THE GEOGRAPHICAL JOURNAL

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The list of lectures for the Session 1954–1955 is not yet complete, but Fellows may like to be informed of meetings to be held in the Society's Hall by the Institute of Biology on September 24 and 25. Fellows of the Society will be welcomed as guests at these meetings, and are invited to make further enquiries at the Institute of Biology, Tavistock House South, Tavistock Square, W.C.1. The provisional programme, under the general title "The numbers of Man and animals," is as follows:—

September 24, 1954. 10.0 a.m.–12.45 p.m. *Chairman:* Sir Alexander Carr-Saunders.

Introduction of symposium by Sir Alexander Carr-Saunders.

Economic theory and the concept of an optimum population, A. T. Peacock (London School of Economics).

The growth of human populations, E. Grebenik (London School of Economics).

An anthropologist's approach to population growth: studies in the Bechuanaland Protectorate, Professor I. Schapera (London School of Economics).

2.15 p.m.–5.0 p.m. *Chairman:* Professor C. H. Waddington, F.R.S.

The mathematical approach to population dynamics, J. G. Skellam (Nature Conservancy).

The mortality factors affecting adult numbers, Dr. D. Lack, F.R.S. (Edward Gray Institute of Field Ornithology, Oxford).

Adverse effects of population density upon the pre-natal life of certain mammals and birds, D. H. Chitty (Bureau of Animal Populations, Oxford).

Experimental competition in beetles, with some general implications, Professor Thomas Park (University of Chicago).

September 25, 1954. 10.0 a.m.–12.45 p.m. *Chairman:* Professor J. Z. Young, F.R.S.

Some biological aspects of population problems, Dr. A. S. Parkes, F.R.S. (National Institute for Medical Research, London).

The relationship between disease control and changes in population growth and age structure, Professor A. L. Banks (University of Cambridge).

The effect of nutrition on fertility in animal and human populations, Dr. J. Hammond, F.R.S. (University of Cambridge).

2.15 p.m.–5.0 p.m. *Chairman:* Professor S. Zuckerman, F.R.S.

Ecology and population studies, Dr. F. Fraser Darling (University of Edinburgh).

Changes in the quality of human populations, Professor L. S. Penrose, F.R.S. (University College, London).

Human population: the future, Lord Boyd Orr, F.R.S.

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The
GEOGRAPHICAL JOURNAL

Vol CXX Part 2 *June 1954*

THE SOUTHERN GLACIERS OF THE STANLEY GROUP OF THE RUWENZORI

DOUGLAS BUSK

WHEN I WAS planning a visit to the Ruwenzori I naturally studied all the maps and photographs available to me in an attempt to clear my mind about the topography of the range. When I came to the Stanley Group there seemed to be discrepancies between the maps and photographs of the Duke of the Abruzzi as published in Filippi's book and an even clearer picture was obtained from Humphreys' photographs in the *Journal*, 82, 6 (1932) 481. Only after my return from the climb was I lent 'Focus on Africa,' by R. and M. Light (published by the American Geographical Society). This has a fine view from the air of the Ruwenzori from the east, clearly showing that the maps were unlikely to be right.

A brief trip in January 1953 enabled us to clear up the position and to establish the existence of several "unknown" peaks, one of which we climbed, and a glacier unmarked, as far as I know, on any map. We make of course no claim to the discovery of these peaks or the glacier, which have been visible to any passer-by for fifty years. It is however a little curious that they should not have been recorded (except as nameless fixed points in an unpublished map, which I only heard of after our climb), particularly as the Duke himself looked down from Savoia Peak into the upper basin of the glacier and saw the hanging tongue of it from his Ridge Camp daily. My companion, Arthur Firmin, has suggested that this blank on the map may be accounted for by the recession of the glaciers, which is marked in the Ruwenzori. Thus to the Duke the "new" glacier might have appeared connected to the Savoia Glacier. I do not myself consider that this theory will hold water. The lowest portion of the ridge between the two glaciers rises 250–350 feet above the "new" glacier and the ice must have receded to a fantastic extent if, fifty years ago, it lapped over the ridge. An alternative theory that the "new" glacier once joined the Elena Glacier is shown by the photographs of 1906 to be untenable.

On the relevant section of the Duke's map, originally published in the *Journal*, 29, 2 (1907), it may be seen that the Savoia Glacier is shown abutting directly against Savoia Peak. Yet in one of the Duke's own photographs of his Ridge Camp, the tongue of the hanging glacier is shown, lying immediately to the south of Savoia Peak and therefore between it and the Savoia Glacier. The view of the Stanley Group taken from Weismann Peak

by Humphreys and published in the *Journal*, 82, 6 (1933), seems to show clearly that the Savoia Glacier was in fact separated from Savoia Peak and that some high unclimbed peaks lay between glacier and peak. Further confirmation of the existence of these peaks was found in Humphreys' aerial view of the Congo side of the range in the same number of the *Journal*.

On the other hand the photograph illustrating Humphreys' article in the *Journal*, 69, 6 (1922) 517, clearly gives the impression that the Savoia glacier runs up to Savoia Peak. Only when one knows it does not, can the dividing ridge be distinguished. When one remembers in addition the prevailing mist and bad visibility of the Ruwenzori the omission of the glacier from the maps becomes quite comprehensible. It was the "discovery" of these peaks that encouraged me to drive from Addis Ababa to the Ruwenzori in order to make an attempt to climb them and clear up the topography definitely.

It took me thirteen days' driving and seventeen days in all to cover the 2300 miles from Addis Ababa, via Nairobi, Entebbe and Fort Portal to roadhead at Ruboni in the Bujuku valley. It would of course have been far wiser from the mountaineering point of view to have flown, because it is difficult to exaggerate the fatigue induced by driving on the appalling tracks one meets in Ethiopia and the Northern Frontier District of Kenya; on our return trip, for instance, by a shorter route, we once required nine hours' going and eleven and a half hours in all to cover our day's stage of 77 miles. Ethiopia is the only country I have visited where pedestrians overtake motor transport on main trunk routes; this happened to us not once but several times. I was however forced to travel by car rather than by air because I had to visit the British Consulate at Mega in southern Ethiopia. This Consulate is incidentally the most remote from railhead, seaport or aerodrome in the world. Railhead at Nanyuki is 300 miles away as the crow flies. Even Kashgar, though admittedly usually approached from the south, is only 220 miles from a railway, while Urumchi has an airport.

I had arranged to join forces with Arthur Firmin, A.R.P.S., one of Kenya's best mountaineers, and he and his companion, Pat Neylan, had decided to await me in the mountains in order to give themselves time for photographic work. I owe the deepest thanks to the officers and members of the Mountain Club of Uganda, who took infinite pains to arrange everything for me in advance. Without this help I could hardly have made the trip, because I do not speak Swahili and collecting porters and supplies would have taken longer than my timetable permitted. As it was, everything was laid on. I picked up the porters' food (maize flour, dried fish, groundnuts, tea, sugar, salt and cigarettes) at Fort Portal and next day drove the 50 miles to roadhead, where porters had been instructed to assemble. The District Commissioner courteously lent me his native interpreter—indeed he enquired anxiously whether I would like an A.D.C. to accompany me on the expedition. The idea of having an aide-de-camp on a mountain struck me as so delightful that I almost accepted. His relief was visible when I refused the offer. Subsequently I discovered that A.D.C. actually meant his only Assistant District Commissioner.

I had been given the names of headmen and luckily the man at the top of the list was available. He never let me down and I can strongly recommend

Kule Kisuki to future visitors: his wizened and aged appearance was wholly misleading. He had an invaluable, if unflattering, comprehension of the failings of Europeans in such difficult country. Whenever I started to flounder crossing streams or in bogs, his rod or staff, shoulder or hand were there to comfort me. Be sure that I did not refuse the proffered assistance. He also carried my still and cinema cameras and film, and a water bottle. Finally, he excelled as a lighter of fires. The Bakonjo equal the repute of the Sherpas at this. No matter how damp the wood Kule would induce it to burn by blowing blasts into the stove that shook the chimney like a reed and threatened to dislodge the cowl.

With his assistance and that of the interpreter, eight Bakonjo porters were engaged and equipped with blankets and sweaters. This ritual has become almost a farce. The porters have now been given so many by different expeditions that they must own two dozen each. In any case only two or three of them actually took them up the mountain; the rest were handed for safe keeping to assembled relatives.

My driver and the interpreter then left and I started off with precisely three words in common with my men. This almost immediately proved an advantage, because they staged a strike, perhaps in protest at the weight of the loads, which were certainly well up to the normal limit of 45 lb. It must have been most frustrating to them to find that no protest to me had any effect. I used one of my three words all round "good, good, good" and departed uphill, leaving Kule to cope. In fact I was rather worried and half a mile on retreated off the track into a bush to await events. It was not long before I counted all eight porters coming past. They did not see me, because if you carry your load on a forehead band you cannot turn your head. Behind came Kule, wearing the pained expression of one of Her Majesty's Ministers who has had a bad moment at Question Time. I clicked my tongue at him and he sank down beside me, muttering explosively. We gave the men a good start and they must have gone at cracking pace in hope of catching me for another argument, because it was two hours before we caught up with the rearguard, who chattered with obvious indignation at finding me behind instead of ahead. However, a repetition of my first word, followed by a few of my second ("Yes") brought smiles all round and we proceeded with comity and forbearing on their part towards my lamentable linguistic shortcomings.

I was now much more preoccupied with my physical shortcomings. The 3500-foot climb from roadhead to the first hut at Nyinabitaba is brutally steep towards the end and I had to restrict myself to a careful routine of one hour's going and ten minutes' halt and a mouthful of chocolate at each stage. I could not of course ask how far we had to go, but I knew it was supposed to be about a four-hour trip. In fact we reached the hut very shortly after my fourth halt. I was profoundly glad to see it.

I would like here to pay a tribute to the Mountain Club of Uganda for their devoted labours in erecting the chain of huts in the Ruwenzori. The Government of the Protectorate have made available the funds for these prefabricated aluminium huts, but all the work of supervising the transport of the pieces and the actual erection fell to the Mountain Club. Anyone who knows the normal weather and abominable going in the Ruwenzori will take his hat

off to those who gave up some of their leave to do this public-spirited work. An illustration of the improvement in the track is given by a comparison between the time taken by Hodgkin (*Alpine Journal*, 53, p. 314) on one section and my own untrained efforts. In 1941 he needed ten hours for the stretch I covered in four hours in 1953. A fit man would now probably only need three hours.

Our second day to the hut at Nyamleju (10,500 feet) was more arduous but far more interesting, because I had my first glimpses of the snows of Mount Speke. On this day the porters were so cheerful that my third word, "Jambo," which I believe to be some form of greeting, was freely bandied. The Mobuku and Bujuku rivers were crossed, the water in each being low. The former involves wading or, if you are very agile, a series of wild and precarious leaps; the latter is providentially bridged by a vast and convenient tree trunk. When the Mobuku is high the crossing can be most unpleasant and even dangerous, though of course ropes are used. Donations are now being raised to provide light suspension bridges here and at the upper crossing of the Bujuku, between Nyamleju and Bigo.[1]

On the third day we really began to encounter the fantastic vegetation of the Ruwenzori. So much has already been written of the helichrysum, giant groundsel and lobelias that, being no botanist, I shall refrain from comment. It is enough to say that it is just the sort of nightmare flora one would expect to find on the Mountains of the Moon. I am strongly in favour of abandoning the Montebello Islands and using the Ruwenzori for the next atom bomb test. Quite enough of the horrible stuff would survive to keep the botanists happy and the rest of us would be able to enjoy easier progress. In particular I would advocate the design of a special anti-nettle bomb. My own encounters with this menace almost cured me of wearing shorts.

I suppose I am also expected to mention fauna. I am in a position to state authoritatively that the visible fauna of the Ruwenzori was reduced by one-third during my visit. One mouse (black) survived in the Nyamleju hut, despite all attempts to liquidate it; one (brown) perished at the Bujuku hut and one (fawn) was spared because of its very tender years, when it ran up my ice axe in mid-path. No other animals appeared, unless you count insects. We encountered a column of safari ants on the path and I wondered how the bare-footed Kule would fare. He merely marched through them briskly, stamping hard at every stride.

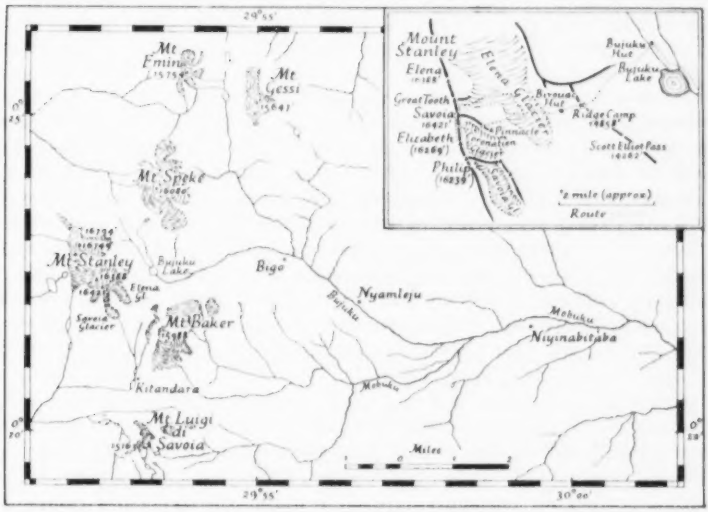
We passed the Bigo hut, which serves as a base for the Emin and Gessi groups and as we approached Bujuku Lake the great peaks began to open up, so I was soon able to enjoy the magnificent cirque formed by the cliffs of Baker, Stanley and Speke. Far up I could see the tongue of the unmarked glacier and the gully to the right (north) of it by which I hoped to gain its upper basin. This appeared to be blocked at the top by 50 feet of vertical ice, which was very disquieting.

At the Bujuku hut, situated 300 or 400 feet above the Lake at about 13,000 feet, I was cheered to find a mixed South African–Belgian party camping. After three days' silence I welcomed somebody to whom I could

[1] Contributions are welcomed by the Secretary of the Mountain Club of Uganda, c/o The Standard Bank of South Africa Ltd., Kampala.

use more than my three words. Here too was a note from Firmin instructing me to join him at Ridge Camp next day. I would have given a great deal for a day off, in which to rest weary limbs and acclimatize, but the perfect weather I had so far enjoyed could not continue for ever and obviously not a moment must be wasted. I therefore duly toiled up next day to the Duke of Abruzzi's Ridge Camp at 14,850 feet, arriving a few minutes before Firmin and Neylan, who came up from Kitandara. Twenty minutes further on and very little higher by the side of the Elena Glacier is the small bivouac hut, shaped like a wedge tent. We did not use this because we could all three squeeze into Firmin's tent.

I could now expound my plans. We were close under the hanging tongue of the unmarked glacier, which was of course quite unclimbable. To the right



of it rose a steep cliff culminating in a pinnacle, then a gully and the face of Savoia Peak. The gully had been descended by the Duke and the ice cliff at the top did not extend right across it, but there was more snow on the rocks than in 1906 and it looked uninviting. Nevertheless we decided to give it a try and at 8.30 next morning Firmin and I set off in perfect weather. Neylan had decided that his exertions of the previous days entitled him to a rest. I may add that this sort of decision is frequently reached by those who accompany Firmin for any length of time. His pace and endurance are killing to lesser mortals. We went up the Elena Glacier easily to the foot of the gully and found it as bad as we had feared, because the strata sloped the wrong way and ledges that looked comfortable from below provided only precarious stances with a layer of unstable snow overlying them. There was hardly a decent handhold all the way up and we were reduced to the knee holds and body clings detested by all mountaineers. The flora gave a final display of

malignity when the rope caught in a gnarled root of helichrysum, which had no reason at all to be growing in such a spot at over 15,000 feet. I had to make a nasty traverse to free the rope and revenged myself by abolishing the horrible vegetable with my ice axe.

The climbing was not very difficult, but it was exacting and treacherous. Run-outs were long, but we had 120 feet of rope and Firmin, who led throughout, found good ice-axe belays in snow patches. This was as well, because lack of acclimatization was telling sadly on me. My muscles were in good shape after the frenzied bog-wallowing and track-scrambling of the previous four days, but my lungs were starved and I don't think I have ever panted so hard. I needed a five-minute rest at the top of each pitch to get my wind and this slowed us down, so that it was nearly three hours before we topped the gully at about 15,600 feet and found ourselves looking down into the upper basin of the glacier, on the other side of which rose the two "missing" peaks. The position is set out in the inset to the sketch-map on page 141.

It was obvious that the peak at the south-east corner of the basin, which overlooks the Elena Glacier and is visible from Ridge Camp, was easy from the basin, but to climb it would take us in the wrong direction. Philip Peak looked a tough proposition, so we turned our attention to Elizabeth Peak, which I had judged from photographs to be the highest. We cut up a steep and rather tricky wall to the col between Elizabeth and Savoia, from which the former was gained by an easy scramble on the Congo side. Assuming that the height of Savoia (16,421 feet) is correct, I estimated Elizabeth at the time as 16,100 feet with Philip not more than 50 feet lower. The unpublished Belgian Ministry of Colonies map (see No. 4 in the attached notes) marks two peaks in just the right positions for Elizabeth and Philip and gives them 16,269 feet and 16,239 feet respectively.

On returning to the col I was allowed a halt to eat something—this, incidentally, is another cross borne by those who climb with Firmin, who appears to be able to exist largely on highly rarefied air. On the day of our climb I can vouch for the fact that his diet consisted of a cup of tea and two tinned peaches for breakfast, three dates during the day and a couple of mouthfuls of stew at night. Total intake of calories about 150. Neylan and I, who like eggs and bacon for breakfast, lashings of chocolate and other light snacks during the day and a pint of good solid stew at night were painfully emaciated by the time we got home. I felt like quoting Isaiah who, in no doubt similar circumstances, remarked "But I said, My leanness, My leanness, woe unto me!" I fear that the servants of Government House at Entebbe will take long to recover from their surprise at my appetite on my return. It was probably the biscuit crumbs in the bed, even after a whacking dinner, that shook them most.

After some light refreshment Firmin rocketed up easy slopes to take photographs from the top of Savoia, while I prospected the ridge down to the north, for we had decided not to descend our gully, if an alternative could be found; such places are always more difficult and dangerous downhill. At first all was well, but then the ridge narrowed. We ought probably to have kept low on the Congo side, but we went down a snow and ice ridge until it steepened and

I left Firmin at a good belay to secure me while I explored. There was a cut-off just below, which we could have overcome by a nasty, twisting jump of some 7 feet down and sideways from a good stance to a tremulous-looking landing; but there seemed to be one or perhaps two more short vertical steps beyond and, when I brought Firmin down to look at it, he vetoed it and then retired up to his belay with encouragement to me to do better. Short of retreating uphill, always an abhorrent thought, the only alternative was a descent from the ridge to the right (east) down to the precipitous snow and ice couloir leading to the Elena Glacier. I edged down a sort of gutter full of incoherent snow and found below me a wall of ice, vertical in all and overhanging in places some 15 or 20 feet high. From the foot of this, though the ground was alarmingly steep, it looked as though we could cut or crampon our way down to the main couloir and the glacier. We were both, I think, determined to get down to easy ground fast. I was tired and Firmin had all the strain of leading a companion, who must at times have appeared most unstable. The idea of roping down, though it meant sacrificing an ice axe, was greeted with enthusiasm, but to be quite sure Firmin secured me on the climbing rope down the wall, much of it in free air, until I could cut a stance for myself and investigate further. All was clear; there was sound snow overlying ice below me, so I came up again and cut another stance just above mine for Firmin to land on. By good luck we judged the distances correctly and, after I had unroped the doubled rope, just reached the stance. Down it Firmin made a neat descent and to our immense relief it followed, when we pulled steadily and cautiously at one end. With only one axe between us care was advisable so we cramponed down face inwards as rapidly as possible, because the rocks at the top of the couloir were plastered with masses of unstable ice, which looked like falling at any moment. We soon reached easy ground and could run down to the Elena Glacier and back to camp.

I must now mention geology and glaciology. The rock is sound and the strata slope wrong on the east and right on the west side. That is all anyone need know about the geology of the Stanley Group. As for the glaciers, I watched them carefully while I was on them, but they neither advanced nor retreated, even when I hit them with an ice axe.

I must repeat that little we did was new. The Duke had descended our gully; he had climbed the ridge we descended; in 1952 Menzies had ascended the couloir to the col at the foot of the Great Tooth, which we tried to reach. We joined up a few itineraries varying from one to forty-seven years old, added a variant or two and climbed another peak. That is all, except that I hope that the next map will be more accurate and that we have established the existence of some very worthy objectives for our successors in the shape of Philip and the peak at the south-east corner of the basin, which I hope will be climbed from Kitandara.

On the two days following our climb we descended, still in good weather, to roadhead, a trek that I found exhausting in its continuation of effort after the previous five days. Clouds started forming behind us, the peaks obscured themselves in their usual mantle of mist and a few raindrops pattered on the windscreen as we drove in Firmin's grossly overloaded Ford to Fort Portal in search of baths and a square meal at last. We had been generously blessed

by perfect weather for a week that had enabled me not only to verify long-range prediction, but given us a climb of sustained difficulty and interest. The road back to Addis Ababa did not seem so long.

It will be remembered that when in 1906 the Duke named the higher peaks of the Ruwenzori, he called them after members of the British and Italian Royal families. The practice was continued by the Belgian Expedition of 1932, which climbed from the west the most northerly peak of the Stanley Group and named it after King Albert. It is normally regarded as preferable to use native names where such exist. For the higher summits of the Ruwenzori they do not and we therefore suggest that an old and pleasant tradition continue to be observed, instead of the rather artificial device of "inventing" native names for peaks and glaciers in which the inhabitants are supremely and perhaps not unnaturally uninterested.

NOTE ON MAPS

The following maps have been made available to me directly or indirectly:

1. Duke of the Abruzzi 1 : 50,000 (*Geogr. J.* 29, 2 (1907)). This is, as far as I know, the only large-scale map of the whole group, though valuable rough sketch-maps have been produced by the Mountain Club of Uganda. The Duke's map is still most useful.

2. Humphreys 1 : 125,000 (*Geogr. J.* 82, 6 (1933)). This is very good, but on too small a scale to be of much value to the climber.

3. De Grunne 1 : 25,000 (Ruwenzori, 1932). This is really only a sketch-map of the Stanley group. It shows clearly the routes of access to the higher peaks from the Congo side, but is inaccurate for the area south of Savoia Peak, which de Grunne did not visit.

4. Map of the Belgian Ministry of Colonies. This is unpublished, but the Vice-President of the Club Alpin Belge kindly obtained permission from the Ministry to inspect it on my behalf. It only marks the lines of ridges and trigonometrical points. Glaciers, rivers, etc., are unmarked. It is valuable for heights.

5. Schweizerische Stiftung für Alpine Forschungen 1 : 100,000. This is unpublished. It is very clear as it shows only ridges and the main features, but it is not as detailed as No. 2.

6. In 1938 a German expedition visited Kilimanjaro and the Ruwenzori and in the latter range (in addition to making two important new routes up Margherita and Baker) conducted a photogrammetric survey of the higher peaks. Owing to the war their report (published in the *Zeitschrift des Deutschen Alpenvereins*, 1939) did not reach England, but it was of course noted in Switzerland where there was yet time for such study and the Foundation for Alpine Research has very kindly been able to send me a copy, which includes a sketch-map in a scale alleged to be 1 : 100,000. To my inexperienced eye the scale appears smaller, but that can happen to anyone (at least it can to me). Later (? in 1940) the expedition produced a map of the Stanley, Baker and Speke groups on a scale of 1 : 25,000 in three colours. I have seen this. It looks good but only a surveyor can say whether it is really accurate. The heights differ from those usually accepted.

7. In 1939 a Polish expedition was active in the range. Owing to the war their account was not published until 1948 when it appeared in *Taternik* (the organ of the Tatra Club). It was accompanied by an admirable sketch-map on

Vertical air photograph: – – – – marks the ridge, from Philip Peak to unnamed Peak II, dividing the Coronation and Savoia glaciers .... marks the routes

Photo: Harward and Maclachlan

Margherita and Alexandra Peaks
Stanley Plateau
Bujuku Lake
Camp
Elena
Elena Glacier
Great Tooth
Scott Elliott Pass
Savoia
Pinnacle
Coronation Gl.
Elizabeth
Unnamed peaks
Philip
Savoia Glacier

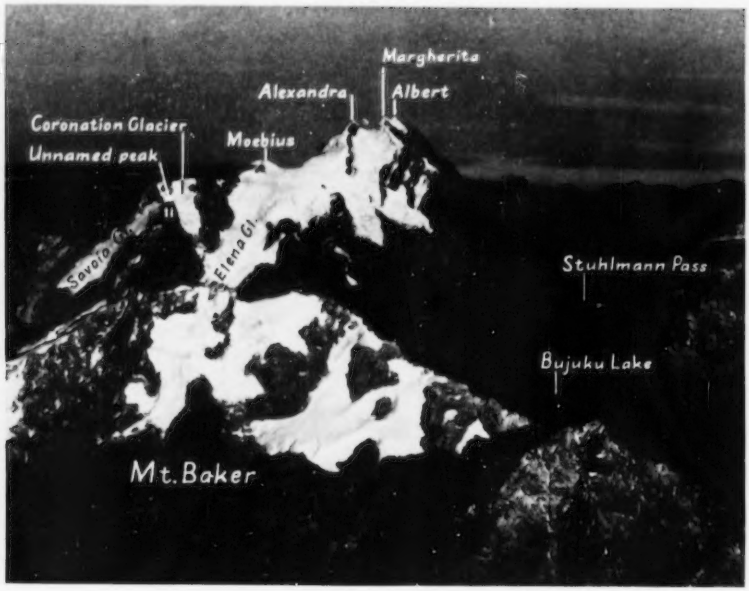


Photo: Harvard and Maclachlan

Air photograph of Stanley group from east-south-east

Photo: Harvard and Maclachlan

Air photograph of Stanley group from south

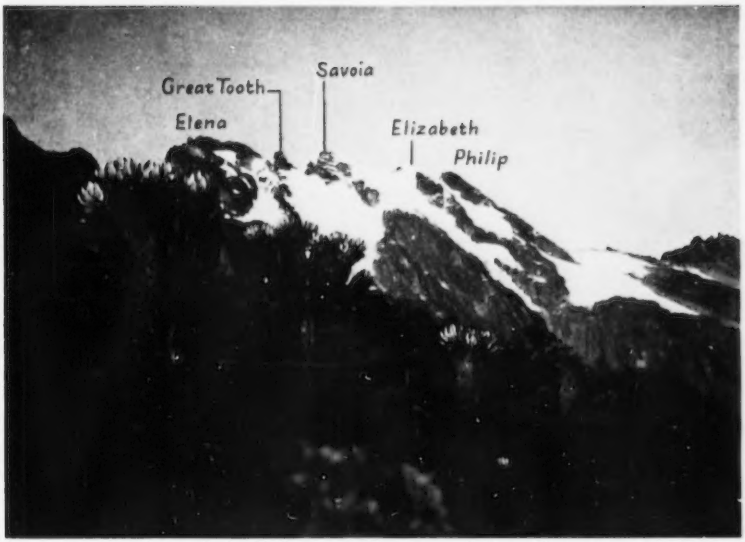
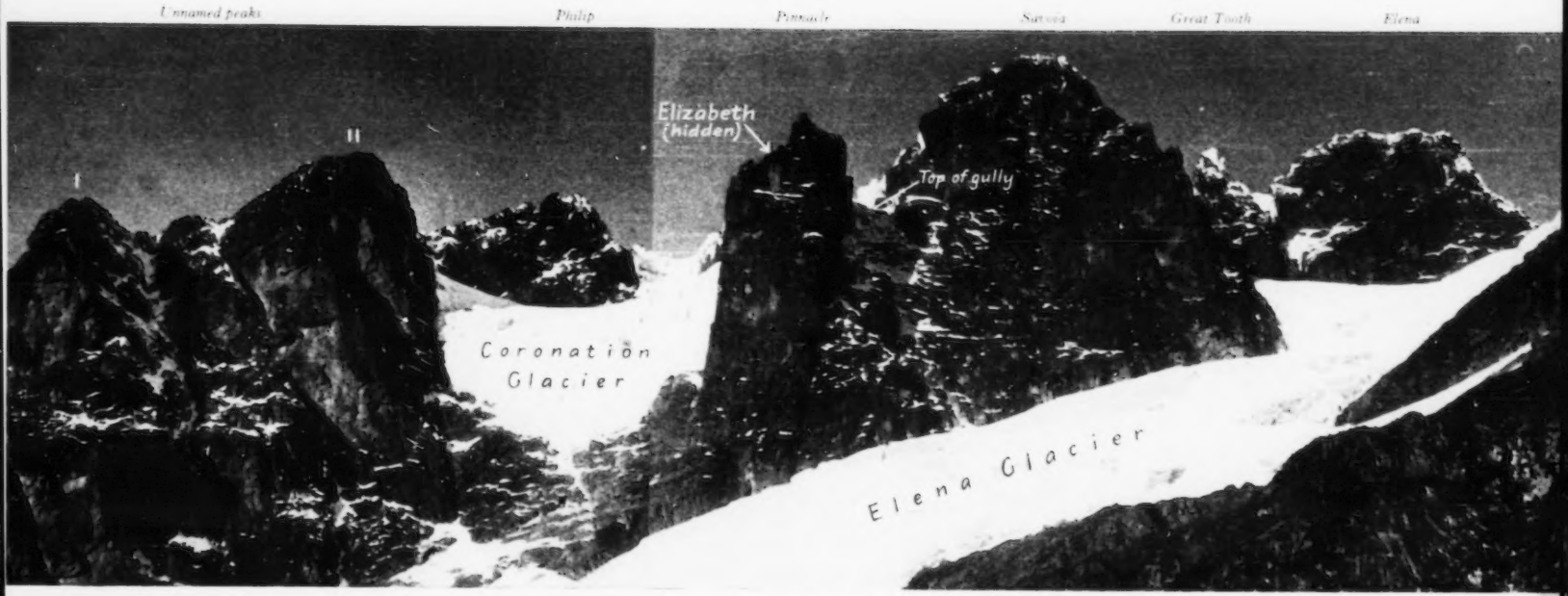


Photo: Mission Scientifique Belge, 1932

South end of Stanley group from west

Photo: Arthur Firmin, A.R.P.S.

View from top of gulley across upper basin of the Coronation glacier



View of Coronation group from Ridge Camp (14,850 feet)

a scale of 1 : 50,000 which is, I think, the best of the lot, particularly if used with Humphreys' map (No. 2 above). It does not mark the Coronation Glacier.

There is of course also the 1 : 250,000 Uganda map, but the scale of this is too small.

In addition there are various sketch-maps in the *Alpine Journal*, *e.g.* 39, p. 99; 53, p. 315; and 54, p. 277. The second is inaccurate in the area of interest to us; the third one is on a small scale and, though very clear, only marks the approaches.

None of the foregoing, except the map in *Alpine Journal* 54, mark the huts on the Uganda side though No. 2 shows routes. No. 3 shows the position of huts on the Congo side, if read in conjunction with 'Congo-Nil,' the guide-book published by the Congo railways (obtainable from Edition Van Assche, 10 Rue Colonel Bourg, Brussels). This has no large-scale map, but describes the ascent to the highest hut and gives tariffs for porters, etc.

It must be noted that nomenclature is as yet far from established, *e.g.* Bigo is sometimes Kigo on the maps. As I do not know the local language I can hazard no theories. I have used names as I thought I heard them.

MY SEVEN YEARS IN TIBET

HEINRICH HARRER

When I left Europe in 1939, as a member of the German Nanga Parbat Expedition, I certainly never thought that I would stay in Asia for thirteen years. The leader of the expedition was another Austrian, Peter Aufschnaiter, and we were to reconnoitre the Diamir face of that difficult mountain. The Diamir side of Nanga Parbat is well known in the history of the Himalaya, for it was here that Mummery and his Sherpas lost their lives at the end of the last century. Actually we found a trace of the disaster—just a piece of wood at an altitude of 20,000 feet.

After several months' reconnaissance, we returned to Karachi where we waited in vain for our freighter to take us back to Europe. The clouds of the second World War were gathering so we made an attempt to reach Persia, but were caught after traversing several hundred miles of desert. Soon we were all behind barbed wire and fortunately nobody had an idea for how long.

Personally, I contemplated escape from the very first day. When we were transferred to another camp, I jumped off our lorry convoy, but was discovered immediately. In 1941 we were brought to a camp near Dehra Dun at the foot of the Himalaya, whose very situation was to me an invitation to escape. The proximity of the Himalaya, and beyond them secret Tibet, was too great a temptation to someone who had roamed through those mountains before. All my life I had been interested in that mysterious country and had devoured all the books about it. Now I had the chance to get there, and perhaps beyond, to China and maybe even the Japanese lines. Plans for such an escape needed careful preparations. I started drawing maps, making shoes and rucksacks and other essentials. I studied a bit of Japanese, Hindustani and Tibetan, all of which saved me from boredom. By the spring of 1943 I was ready, and one night an Italian General and I climbed over the barbed wire. For a few ghastly seconds we got entangled, but by the time the Gurkha guards started shooting we had reached the jungle. For three weeks we marched only by night. Then, a few days short of the Tibetan border we were caught and brought back to the camp. On our return journey I made another attempt, dropping down from the second storey of a forest bungalow, but after forty-eight hours I was rounded up again.

Back at the camp I passed twenty-eight days in solitary confinement, the regular penalty for breaking out. Then I started preparations all over again. For months I drew maps and collected the necessary paraphernalia. Winter passed swiftly and when spring—and with it the "escape season"—began, there were quite a number of candidates for the Escapers' Club. Two friends of mine, who spoke fluent English, aimed at reaching Burma by crossing the plains of India. But the remaining five, including myself, wanted to win through over the Himalaya to Tibet. We planned a common escape, and agreed that once outside everybody should go his own way.

In April 1944 five of us dressed up as Indians, and two as English officers. Ostensibly, we were members of one of those (to us) familiar squads for

repairing the barbed wire. When we looked at our make-up, we could hardly repress our smiles: we carried ladders, pots of tar and rolls of barbed wire, and could hardly believe that everything had gone so smoothly when at last we stood in the jungle and got rid of our stage properties. The others went in twos but I decided to try alone. After crossing several passes (see Route 1) I came to the upper regions of the holy Ganges, here called the Bhagirati. Following the pilgrims' route, made famous by Kipling's Kim, I reached the last village this side of the Himalaya. It had taken me ten nights and the name of the place was Nelang, standing at 11,000 feet. At this time of the year it was still uninhabited. But to my delight my four camp comrades had chosen the same route and we were all united again, until one of the party had an attack of mountain sickness and decided to return to the prison camp.

After a day's rest, during which each told his story, Kopp from Berlin, Treipel from Salzburg, my friend Aufschnaiter and myself set off. During our earlier journeys we had all of us encountered leopards and bears, but now the greatest difficulty became the shortage of food. On top of that each of us carried between 80 and 100 lb. on our backs and we were feeling the effect of the rarefied air. Once we went up the wrong valley and lost several precious days, but at last on May 17 we stood, the four of us, on top of the Tsangchok La, a 17,200 feet high pass over the Himalaya. Here at last we were on the frontier between India and Tibet, for so long the object of our dreams. As the stone cairns and prayer flags showed, we stood at the gates to an entirely new world. We were near starvation and our only wish was to reach some inhabited place and get something to eat. All round us we saw nothing but mountains, gorges and again mountains. We intended to present ourselves to the Tibetans as neutrals and as such we hoped soon to meet some district officer. But it took us several more days walking before we reached the first Tibetan village, a group of six houses called Kasapuling. Here everything was exactly as we had read so often in travel books on Tibet. The people were extremely inhospitable and even denied us entry into their houses. They refused to sell us any food, and only by threats did we succeed in buying the oldest billy-goat available. We had to pay a shamelessly high price, to which we agreed only because we wished to enter the country in a friendly way. The first Tibetan officer we met wouldn't hear of our staying; the word "neutrality" was of course unknown to him. We appealed to the higher authority of the Abbot at nearby Thuling, but to no avail. Accompanied by a Tibetan soldier, we were escorted back over the Himalaya to the Indian border at Skipki. Here we passed ourselves off as American soldiers, bought fresh supplies, and Aufschnaiter, Kopp and myself made a new attempt. Treipel however had had enough and returned to the camp via Simla.

So it was that, striking north from Skipki, we crossed the Himalaya for the third time over two passes of 18,000 feet, and came eventually to the upper regions of the Indus. Here we turned southwards again and reached Gartok, the capital of Western Tibet. The name "capital" is rather pretentious for the two hovels of which Gartok consisted, but the two viceroys who lived there ruled over a country at least as large as Great Britain. They were the first cooperative officials we had met, and after ten days' negotiations, we continued our march with the help of travel permits. We had to give our word of honour that under no circumstances would we go to Lhasa from their

province. Nevertheless, we were very happy because our permits took us roughly in the right direction, south-east through Tokchen to Tradun. And at last we had official transport.

For a whole month we saw no inhabited place of any size. Our route took us through desolate country, past nomad camps and isolated *tasam* houses where one could change yaks and find a lodging. After some weeks we came within sight of Mount Kailas (22,000 feet), the holy mountain where many pilgrim roads converge. We passed many cairns built, a few stones at a time, by passing pilgrims, and also the typical *chortens* of Tibet which mark the tombs of the high lamas. Some pilgrims come thousands of miles and spend a lifetime on the way, covering the route by the length, or even by the breadth, of their bodies. We met two such holy travellers who had come from the Province of Khan, 2000 miles distant. Prostrated, face downward, they creep the same way back, and some never see their native land again. Their only food is flour or butter tea which they get from nomads or other pilgrims. Sometimes rich men pay a "professional prostrator" to do the journey for them—this member of "The Club of Queer Trades" wears wooden iron-lined gloves and a great leather apron. Among the people we met on our way was a young couple on their way to Kailas: round their necks they wore silk scarves, and the woman had a brocade sunshade and shawl, for Tibetan women do not like to appear sunburnt, even powdering their faces to simulate a fair complexion.

Over several more passes we came to the source of the Brahmaputra, here called the Tsangpo. Always marching along the northern face of the Himalaya we reached Tradun, the terminus of our Tibetan travel permit. From here we had the most beautiful view of Dhaulagiri, Annapurna and Manaslu, and Aufschnaiter and myself decided to stay as long as possible. Kopp accepted an invitation from the Nepalese Government, went to Katmandu and of course ended back in the prison camp soon afterwards. We sent applications to Lhasa, but the Tibetans permitted us only to travel a few hundred miles further east, and again crossing the Himalaya, we came to the village of Kyirong, eight miles from the Nepalese border. The district officers expected us to leave Tibet immediately for Nepal, but they had not counted on our persistence, and Aufschnaiter and myself stayed eight months in this most wonderful place. Amidst the Himalaya 9000 feet high, the contrast between the glaciers which flow right down to the village and the flowering rhododendron woods through which they pass, is incredibly beautiful. In the thick woods you find a number of hot springs and on one of our daily excursions I found tracks of some being above the tree line. Though Tibetans often told me of the *khangmi* or *migo*, which is what they call the mysterious "abominable snowman," personally I believe the tracks to be of bears in winter and of the huge langur monkey during summer.

Around Kyirong were about sixty monasteries, some of them perched on rock faces like birds' nests. Milarapa, the famous Tibetan poet-saint, lived here in the twelfth century, and that is why Kyirong is especially holy. We had plenty of time to observe the peasants who, like most other Tibetans, live mainly on *tsampa* and butter tea. *Tsampa* is made by parching barley in hot sand and then grinding it to a tasty flour with a handmill. It can then be mixed with beer, milk or curd, but Tibetans really prefer butter tea. They

boil coarse tea with salt and soda for hours on end and put the brew in a churn. A lump of butter is added, and the resulting emulsion is the famous butter tea. Unfortunately the butter is always rancid and the brew tastes unpleasant at first, but one gets used to it and even comes to love it. The Tibetans would prefer fresh butter, but it sometimes takes months and often years to reach its destination. They get milk and butter from the female yak, the yak being a long-haired sort of oxen, which likes the cold and rough climate.

In Kyirong we heard from Nepalese merchants that the war was over. But Aufschnaiter and I didn't think of giving up our freedom so easily. As Europeans of the twentieth century, it was far too fascinating to live here in the Middle Ages. But the Tibetan officials wanted us to leave, so we decided to make a try for China via the northern plains. The greatest obstacle in this plan was the crossing of the Tsangpo. We knew there were big wooden ferry boats to be found, and we hoped to come on one, for the Brahmaputra at 12,000 feet is already a considerable stream. The previous summer we had swum through the Tsangpo once, when the Tibetans refused us the ferry, but now it was winter and moreover we carried packs of some 90 lb. The commonest way of travelling on the Tsangpo, or crossing it, is in a yak-hide boat. The boatmen carry their heavy boats, weighing some 200 lb. over passes 18,000 feet high to Lhasa or from wherever they come.

We made a dramatic departure from Kyirong, for the Tibetan authorities had not relented, and a close watch was kept on our movements. Again we marched only by night; the temperature never rose higher than −20° C. (−4° F.), and we felt it worst when wading through rivers. Despite the cold, we continued sketching and, since we were passing through absolutely unknown country, Aufschnaiter took the bearings of the mountains. In the first nomad settlement we reached we got new provisions and also bought a yak. It was a wicked animal. I led him with a nose-ring and Aufschnaiter tried every way to increase his speed of 2 miles per hour. He used to rush at me and try and toss me, but fortunately his horns were so wide that I always ended up by sitting on his forehead. We crossed the Himalaya for the fifth time at the pass of Karola (18,000 feet); our yak forced us to an ice-cold bivouac on top of the pass, but we were rewarded with a magnificent view of Mount Everest which stood close to the south in the moonlight, and the first rays of the sun on its summit were an unforgettable experience. After a few more days of walking we reached the Tsangpo valley. The Tsangpo was indicated only by a dotted line on our maps, and we were rather surprised to find a huge chorten at the point at which we struck the river. It was like a miracle to discover that we had arrived at a place where a hanging rope bridge crossed the stream. We strode over ourselves, persuaded the yak to swim, and after a few more passes came again to the big caravan route, leading from Western Tibet to Lhasa. We paused at Sangsang, for here we had to come to a great decision. Our money was running out, it was quite clear that we should never reach China and a great desire to see Lhasa had arisen in us. Along the main caravan route we could have got there in about four weeks' walking, but not daring to do this, we decided to try the northern plains, which Tibetans call Changthang. Sparsely inhabited by nomads and robbers, not even the local people venture to go there during winter time. It

was December 2 when we set out; the inhabitants of Sangsang thought us absolutely mad, and it was certainly a good thing we didn't know what difficulties lay before us. We struck north across the Transhimalaya range and walked on through snow and ice. Not knowing the real danger of brigands we disregarded the warnings of the nomads and this nearly cost us our heads. We walked right into their arms and escaped only with the greatest of luck. The following weeks were the hardest in all my life. We marched 20 to 25 miles daily in temperatures around −40° C. (−40° F.), we hardly ever slept and our food consisted only of dry meal and raw yak meat. We hardly ever slept because of the cold, and it was a relief when we at last reached the northern trade route, called "Gold Caravan Road." Of course there was no sign of a road, but from now on we knew that every now and then we would meet nomads and could buy mutton or beef. Formerly Tibetans used to dig gold in these regions, but their only tools were gazelle horns, and eventually they gave it up. Only the caravan route keeps the name. In the distance we saw the mountains of the Nyenchenthanglha range running up to 24,000 feet, and we wondered how we would overcome this obstacle. We passed by the great Nam Tso Lake and crossed the big range over the Gurring La, 20,000 feet high, and probably one of the highest passes in the world.

On 15 January 1946 we saw the golden roofs of the Potala, gleaming in the distance, and we felt inclined to drop down on our knees like the pilgrims. Almost two years had passed since we broke out of the camp. We had walked on foot about 1500 miles, and crossed sixty-two passes between 17,000 and 20,000 feet. Our first full view of the Potala, that unique palace of the Dalai Lamas, was unforgettable. More than a thousand years ago a castle stood on the same rock, but it was the great fifth Dalai Lama who had it built in its present form. The Dalai Lama died before the Potala was completed, and the government kept his death a secret for many years; the population would not have worked for a regent, for government work gets no pay and is considered a sort of tax. On top of another rock stands the second landmark of Lhasa: the medical college on the Chagpori. The Tibetans have quite a knowledge about herbs and their usefulness, although surgery is entirely unknown.

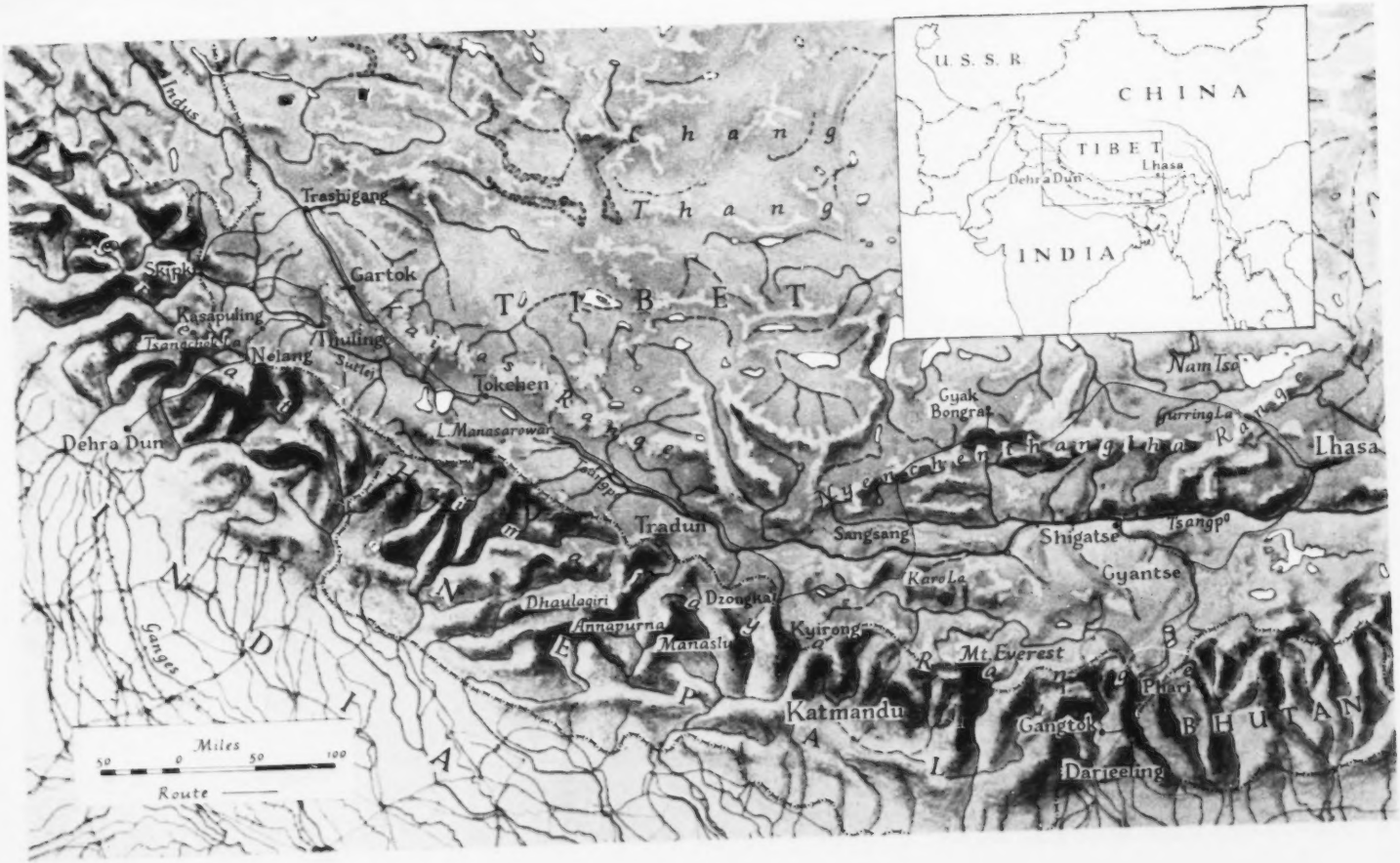
Now at last we stood at the gates of Lhasa. We had often heard of police guarding the entrance to the holy city, but in fact only a few beggars held out their hands to ask for alms. A few steps brought us to the first houses; hesitantly we approached one and asked for refuge. With screams and abuses, we were sent away and only after crossing almost the entire town did we venture again to enter a courtyard. But the same unfriendly reception greeted us. In spite of the uproar we decided to sit down and simply refused to budge: that day we had walked 26 miles without anything to eat, and our blisters had grown to the size of a hand. Presently a change in the atmosphere showed itself: those who had turned us away from their houses when we entered the city now atoned for their inhospitality by approaching us with tea and tsampa-meal. We didn't look very trustworthy, with our huge beards and wearing sheepskin which was in rags. But we were soon surrounded by a huge crowd; then, when we had been there some time, a richly clad Tibetan addressed us in fluent English, and promised to take us to his house, provided the government would give its permission, for even a member of the nobility

could not give us asylum without the permission of the magistrate. Apparently he succeeded, for after a short while servants came to accompany us to the nobleman's house. Here, for the first time, we saw the immense difference between the Lhasa aristocracy and the common people. Servants rushed in and out piling up a variety of food in front of us, which disappeared in a manner contrasting sharply with our noble surroundings, and during the next few days the house was full of visitors. None came without a present, for once you are officially admitted, Tibetan hospitality knows no limits. Although under a kind of house-arrest during these first days, we were soon asked to call on the parents of the Dalai Lama. Our host instructed us how to present the white scarves; for when paying visits or submitting a petition, one has to give silken scarves. The mother of the Dalai Lama received us sitting on a small throne, and though of humble origin, she looked the picture of aristocratic dignity. After their son was discovered to be the incarnation of the Dalai Lama, the closest relatives of the young God-King automatically became the nation's First Family. The government presented them with large estates and a great amount of jewellery; some of it, in solid gold ornaments weighing about 40 lb. Lobsang Samten, the Dalai Lama's elder brother, who did the interpreting, spoke Tibetan quite fluently, yet with the strong mountain accent which we had learned from the nomads and peasants 1000 miles distant, and which could hardly be understood by the Lhasa high society. The Dalai Lama's youngest brother, who was born after our arrival in Lhasa, was also recognised as an incarnation; their father died soon after we arrived in Lhasa. I was amazed how little grief seemed to befall his kin: the Tibetans do not mourn for their dead in our sense of the word. Sorrow at the parting is relieved by the prospect of rebirth, and little respect is shown to the corpse which is dismembered and given to the birds to dispose of. One day's ride from Lhasa is the mountain on the top of which only members of the aristocracy and high lamas are dismembered and given to the vultures.

In the meantime we had moved from our first quarters to the palace of Tsarong, one of the country's richest men who, for his services to the late Dalai Lama, had been presented with large estates. He was married to three sisters, which is extraordinary even for Tibet where you can find any form of legal marriage. Normally, a woman marries all the brothers of a family, thus preventing heritage disputes. Another way to avoid a division of estates is that father and son marry the same woman. Once it took me quite a long time to find out how it was possible that one girl's mother was also her sister-in-law. Women of the Tibetan aristocracy have no political rights whatever, but they enjoy their lives and have a full social existence. They take trouble with their appearance, and always have plenty of magnificent jewellery; I have seen the wives of high-ranking Tibetan officials loaded with gold ornaments, sometimes up to the value of thousands of pounds. Women in less important walks of life, though not allowed to wear pearls, still have fine ornaments and decorate their hair with colourful tassels. There is a big difference between the children one sees begging in the Lhasa streets and the young aristocrats. The children of the Tibetan nobility have each a personal servant, brought from the father's family estate, and given full care of the child's well-being.

As I say, Tsarong owned large estates. But actually he did not own then, since everything—land, mountains, valleys, animals, flowers—belong to the Dalai Lama who is not only the king of the Tibetans but their living god. The way in which, after the death of a Dalai Lama, his successor is found, is certainly one of the last mysteries of our time. Prophecies and oracles play a great part in the selection of the new Dalai Lama, and it would take too long to explain all the details of this procedure. It is a common mistake to assume that the new Dalai Lama has to be born exactly at the hour of death of his predecessor. Often years pass by until the new ruler is found. During this interval, a regent rules the country, but a sigh of relief heaves through the nation when at last the new Dalai Lama enters his residence with oriental pomp. It is a fine sight to see the Dalai Lama riding through the capital in a procession preceded by the cooks wearing similar hats to their European colleagues. Just in front of the Dalai Lama's palanquin, walks the chief abbot, one of the most powerful men in the country, and then follows the richly adorned sedan chair, carried by thirty-six bearers. These processions take place twice a year, in spring and autumn. But the main event in Lhasa is the New Year, the great celebration in which the whole population shares. During the three weeks of New Year festivities, the secular government retires and the capital is ruled only by monks. The population of Lhasa is about 25,000, but during this time monks and pilgrims bring it to three times this figure. Twenty per cent. of the male population of Tibet are monks who live in monasteries. Sometimes the streets of Lhasa are crammed with them, and it is better for a foreigner not to move about too much. During their religious performances they are likely to get into a state of religious ecstacy which may become dangerous. Once you get to know their language however there is nothing fierce about them. I never saw people laugh as much in their daily life as the Tibetans do. The keeping of law and order is entrusted to monk-soldiers, called Dob-Dobs. They pad their shoulders and darken their faces to look even fiercer than they actually behave. They make frequent use of their whip and stick, and I often wondered why the masses take their whipping so patiently. The culminating moment of the New Year celebration is when the State Oracle staggers through the streets in a trance. It is then that this young man is possessed by a god who utters oracles and prophesies through his mouth. These monks die young, for the mental and physical strain of these seances is killing.

There are many more festivities in Lhasa during the year, on one of which a huge banner is displayed on the Potala. This building houses the banner which is hoisted only for two hours every year. Embroidered with gold and silver brocade, it is so heavy that thirty monks are needed to carry it. Below the banner, monks perform a religious dance, wearing ornaments of human bones, and thousands of picturesque masks are to be seen. I would give you a very incomplete picture of the Tibetans if I did not stress the overall importance of religion in their daily life. In no other country in the world do people pray and offer as much as they do in Tibet. The prayer wheels are kept going constantly, rolling in their drums millions of "Om-Mani-Padme-Hum," the Tibetan prayer formula which may be translated as "Hail, oh jewel in the lotus flower!" Sometimes the prayer-wheels are turned by wind, sometimes by water, often by hand. Not all of the three hundred thousand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Route

Tibetans with yak hide boat

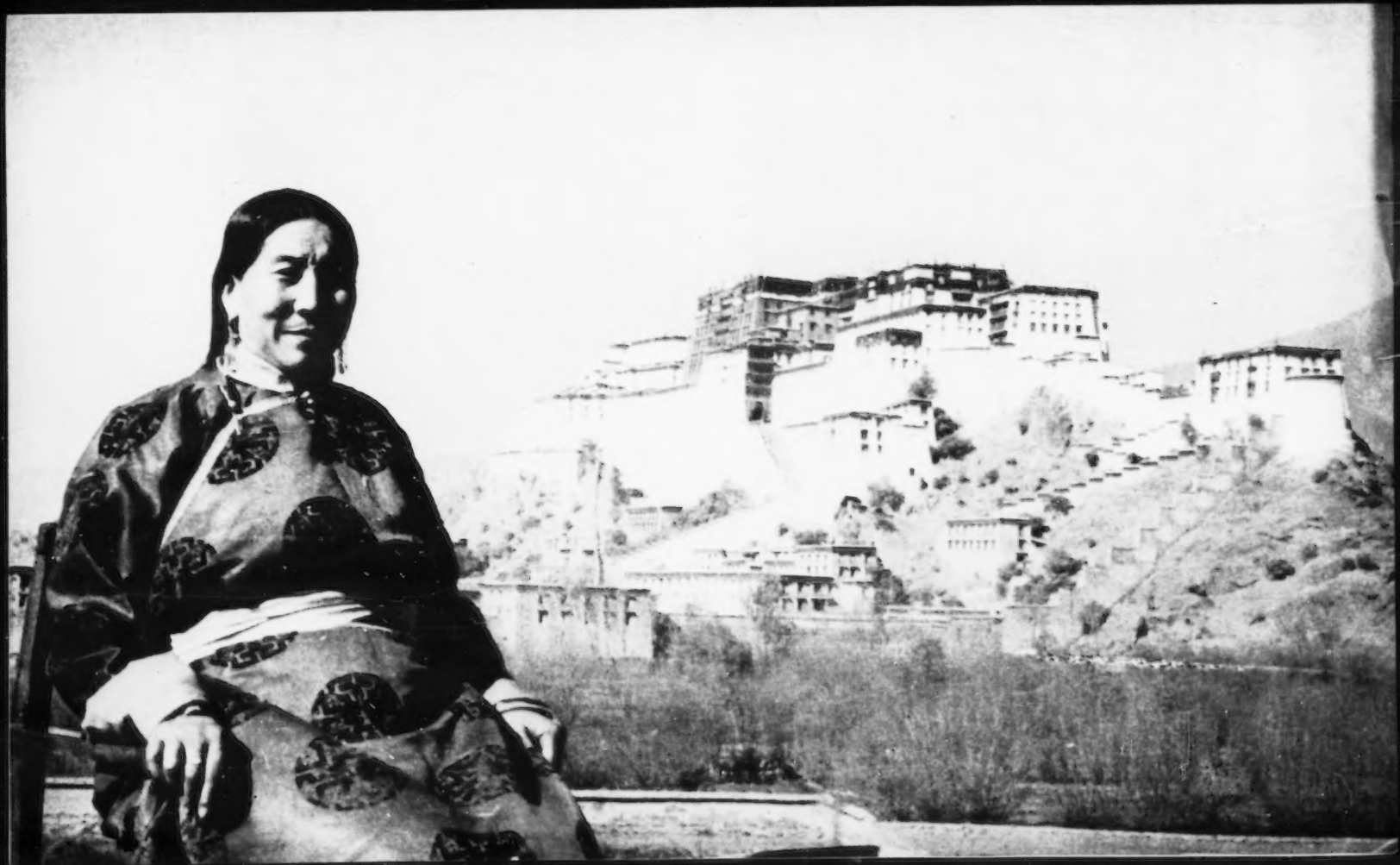
Kyetsang, typical mountain monastery

The plain of Lhasa beyond the golden roofs of Sera Monastery

Heinrich Harrer

The Dalai Lama's sister with Peter Aufschnaiter

The mother of the Dalai Lama; beyond, the Potala



The Dalai Lama with his courtiers

Effigy, made of butter, carried in procession

Reviewing the Tibetan army before the Chinese invasion

The flight of the Dalai Lama from Lhasa at dawn

monks in Tibet are scholars and divines; only a few of them actually know the Tibetan scripts, and the majority are servants in the big monasteries. There are religious houses in Tibet which house up to ten thousand monks.

Lhasa street scenes are full of variety, and one has ample opportunity to observe all classes of the Tibetan population, especially during the New Year festivities. The Tibetans are of Mongol race, but their eyes slant less than those of the Japanese or Chinese. The beggars are a great feature of the life of Tibet; there are more than one thousand of them in the capital alone, and their main characteristic is laziness, for they prefer sitting in the sun to hard work. Since nobody turns them away, they earn a day's living by one or two hours of hard begging. On Buddha's birthday, convicts are permitted to beg in the streets, chained together with iron bands. Children of the street, clad in rags, looked pathetic to us at first, but their unkempt look is part of their profession, since they are beggars too. But Lhasa is not entirely a city of mendicants; the shops are full of goods where the well-to-do can obtain everything they want either for use or for amusement. You can buy anything in Lhasa's stores, from binoculars to American gramophone records. In a country where modern sanitation is unknown, Elizabeth Arden cosmetics are most popular and easily available. Everything is man-handled in Lhasa, the invention of the wheel is regarded as too new to be safely adopted; I tried to make my workmen use some kind of wheel-barrow when I was building an embankment, but they preferred to carry the heavy material to and fro.

In all these experiences I enjoyed the wonderful companionship of my friend Peter Aufschnaiter with whom I shared not only the seven years in Tibet but practically my entire time in Asia. For him the lure of the East has proved so strong that he decided not to return to Europe and now lives in India as a cartographer and agricultural engineer. Although he was fourteen years my senior, he stood up to the hardships of our travels often better than I did. We made ourselves useful wherever we could in Lhasa, and even received a monthly salary from the Government, for which we were given letters of payment entitling us to a certain sum of Indian rupees or Tibetan *sangs*. Aufschnaiter was building a water channel, and together we mapped the whole town of Lhasa; there were some drawings of the capital in existence, but Aufschnaiter and I were the first people to survey the capital with theodolite and measuring tape. Our map showed how the main temple, the Tsuglagkhan, stands in the centre of the town and how around it runs the small circular road. The great circular road includes the Potala and is 5 miles long. In a corner of the map I added, in Tibetan handwriting, some of the names of over a thousand houses which I collected. A Tibetan-drawn map would be far more picturesque than ours! Aufschnaiter was an agricultural engineer by profession while I had studied geography. But in Lhasa we had to be jacks-of-all-trades wherever western ideas were to be carried out. And so I built a river embankment protecting the summer gardens of the Dalai Lama and constructed a fountain in the garden of Tsarong's house. The Tibetans love their gardens, and this fountain was much admired.

I made one good friend in Lhasa, a monk officer named Wangdu, whose grandfather had been Regent of Tibet. He was not only very intelligent, but also extremely talented in any kind of sport. He joined me in tennis and

The flight of the Dalai Lama: passing Shigatse on the way to the Indian border

ice-skating, and even accompanied me on my mountain-climbing tours. From the summits near Lhasa we had wonderful views of the surrounding mountains, and we found some beautiful spots—for instance, a lake at 17,000 feet, of which the shores were lined with wild yellow and blue poppies.

The Dalai Lama was an ardent photographer, and it was photography which brought the first contact between us. It is difficult to imagine in how simple, primitive and lonely a way the God-King lived. Nobody was supposed to address him, not even a Cabinet Minister. But it was a sign of his strong will when one day he sent me an order to build a small cinema in his summer garden. At that time I had often used his 16mm. movie camera and it was apparent that he now wanted a chance to look at these films. The camera was a present from the British Mission in Lhasa, the only western diplomatic representation in Tibet. For the Dalai Lama, this cinema must have meant a big change in his routine daily life. Otherwise he was confined to the uppermost storey of the Potala, almost like a prisoner. Just below him, the Regent had his quarters, followed by the Chief Abbot and so on, exactly according to rank. Here the Dalai Lama grew up without family and playmates. His only recreation was a pair of binoculars with which he liked to watch his subjects from afar.

I had often had a glimpse of the Dalai Lama during the processions, but I saw him face to face for the first time during one of the great receptions in the Potala. I sat on a small rug in the throne-room and counted more than seven thousand people filing past their ruler. Everybody was offering presents, poor people just a copper coin while rich merchants carried rolls of gold brocade. Each of them got a blessing from his Holiness and left with a good-luck scarf. During my visit to the Potala I saw the enormous gold statues which were proof of the reverence the Tibetans show towards the Dalai Lamas. One golden Buddha, for instance, is more than nine storeys high.

After having completed the cinema, I was entrusted by the Dalai Lama with handling the projector and showing him the films. And that was the beginning of a real friendship between the fifteen-year-old ruler and myself. I soon found myself teaching him geography, mathematics and English. He was extremely intelligent and eager to learn about our way of living. And although he did put some rather difficult questions, I tried to answer them as well as I could.

Thus my life in Lhasa began to take a new course. But happy though this time was, it was already darkened by political clouds. The Chinese started to threaten Tibet's independence and the Tibetan National Assembly decided to appeal to the United Nations. They took no action however and in the autumn of 1950 the Chinese invaded Tibet. They crossed the border at six different points with a total of twenty thousand troops. Of course it was impossible for the small and outmoded Tibetan army to cope with this enemy and so the Dalai Lama, in December of that year, fled to Gangtok on the Indian border. On this trip I could not help but remember the old saying which I had heard in Lhasa, that the thirteenth would be the last in the succession of Dalai Lamas. Although my friend had been initiated as the fourteenth Dalai Lama, he had to quit the capital. It was his first trip across the country and from near and far his subjects had come to see him, for his

mere presence meant a blessing. Everywhere incense-fires burned and the whole escape route was lined with pebbles to protect the God-King from evil spirits.

When I left Tibet after seven years it was again an escape. This time it was the Communist Chinese I was fleeing from and although I was in a much better state than seven years ago—with servants, luggage and horses—and though I knew that I was returning to my home-country, I felt far from happy. For I probably would never see my friends again. And the Dalai Lama? Officially he is still the ruler of his country. Personally he is a prisoner in his huge palace, a puppet of the new masters of his country. But I hope that perhaps the eternal God of Grace, who is manifested in the person of this young man, will survive this soulless regime as he has survived so many earlier Chinese invasions that over the centuries have swept across the land of Tibet.

DISCUSSION

Evening Meeting, 1 February 1954

Attended by Her Royal Highness the Duchess of Kent, Honorary President

Before the paper the PRESIDENT (Mr. J. M. WORDIE) said: Your Royal Highness, Your Excellency, My Lords, Ladies and Gentlemen—The lecturer tonight is a man of great resource and determination and his climbs in Switzerland are well known. He was the first man to climb the North Wall of the Eiger, regarded as one of the most difficult feats of mountaineering.

Mr. Harrer then read his paper

His Excellency the AUSTRIAN AMBASSADOR: It is my privilege to thank the Royal Geographical Society and your President for the honour they have given to my compatriot. An article which I read yesterday in the *Sunday Times* said that the Royal Geographical Society retains its sympathy for the individual and is still a place in which anyone with serious and original ideas may be assured of serious and informed consideration. I think that is exactly what Harrer is feeling. He is above all a mountaineer who takes his task seriously and one who gets into and out of trouble easily. It is one of the nice things after such an expedition to feel safe, and I cannot imagine any way in which one would feel safer than in coming to England and feeling the atmosphere of freedom and appreciation.

Lt.-Col. F. M. BAILEY: It is nearly fifty years since I left Lhasa on the little expedition to Western Tibet which was referred to by Harrer just now. We travelled, as he did, in mid-winter. Temperatures were down to 25° below zero; in his case it was 40°. We went to heights of up to 19,000 feet; in his case it was 20,000 feet; I know what it all means!

We travelled in considerable comfort—though we did not think so at the time—and had tents and warm clothes and warm boots. He had none of those things, and I am amazed at the way he was able to go through that terrible journey with the results he has shown us, and at the way he has been able to increase our interest by the photographs we have seen.

I want to say one thing about the Tibetan Government. I think they deserve some credit for being good enough to put these two refugees into the position to make their way as they did, and of course we admire them for having taken the opportunity.

RECENT ECONOMIC TRENDS IN ARIZONA

W. G. V. BALCHIN AND NORMAN PYE

This paper is based on a lecture at an Afternoon Meeting of the Royal Geographical Society on 1 June 1953. The statistical information has been revised to include 1952.

THE LAND IS SO immediately the basis for the several ways in which men have won their livelihood in Arizona that a true insight into recent trends in the State's economic development demands the geographer's characteristic approach from land genesis through land quality to land use.

Arizona occupies parts of two great physiographic provinces. The boundary between them is readily discernible both on the physical map and in the field as a raggedly indented escarpment that passes roughly north-west to south-east through the central parts of the State. To the north-east is the Colorado plateau, its general surface ranging between 4000 and 9000 feet, but in places deeply carved by the Colorado river system. As this great block of the earth's crust was being raised, the rocks of the rim were folded, faulted and tilted. Accompanying igneous activity produced on the one hand the lava flows that today cover hundreds of square miles along the border of the plateau, and on the other hand, in a belt on the south-west of the plateau edge, the copper and other metal deposits that are the basis for a great mining industry. Evidence of the continuation of volcanic activity almost to the present day exists in the area of volcanic cones north of Flagstaff; the most prominent of these is San Francisco Mountain (12,611 feet) and the most recent is Sunset Crater last active in A.D. 1066.

The south-western parts of the State lie in the Basin and Range province. Here the mountain ranges are regarded as having originated as elevated fault blocks, whereas the intervening areas were relatively depressed and gave rise to interior basins or bolsons. Into these bolsons intermittent streams have transported rock fragments eroded from the surrounding mountains, so filling the basins to depths of more than 1000 feet in places. The denudation of the mountains and the slow filling of the depressions with loose rock material has produced, through Tertiary and Quaternary times, the broad flat plains fringed by peripediments and pediments that now separate the mountains of southern Arizona. The mountain ranges are roughly parallel and follow the structural trends which are predominantly north or north-west. The region north-east of Tucson and Phoenix has the highest ranges (*e.g.* the Santa Catalina, over 8000 feet), and there is a general fall in height south-westwards to desert plains near Yuma that are but 150 feet above sea level (See folding map). Although at one time areas of interior drainage, most of these plains now have rivers which drain to the Colorado system, and the deposits of older alluvial fill have been cut into and dissected by through-going axial streams. The highest level reached by the deposits occurred in

Quaternary times; these have since been subjected to at least three and possibly four phases of erosion, each succeeding phase being responsible for successively lower incisions and the creation of minor escarpments. Rejuvenated peripediments and pediments are now characteristic of the morphology throughout this area. The latest period of erosion and subsequent deposition has formed a comparatively narrow inner valley comprising the bottom lands which are underlain by younger alluvial fill. From the standpoint of agricultural development and the availability and use of water for irrigation this inner valley, or recent flood plain, is of primary importance.

The larger geomorphological contrasts are repeated in significant climatic differences within the State. The general dryness of Arizona affects all aspects of its life, but whereas at one time it was generally supposed that Arizona was part of the Great American Desert, actually only two parts of the State can be considered as typically arid—the south-western Sonoran Desert and the north-eastern Painted Desert. The various parts of the State experience different climates mainly because of differences in altitude. Annual precipitation varies directly with elevation, being 3·1 inches at Yuma (141 feet), 8·9 inches at Phoenix (1108 feet), 16·7 inches at Globe (3525 feet) and 22·8 inches at Flagstaff (6902 feet). On the plateau the heaviest rainfalls, 15–20 inches and occasionally 30 inches, are confined to the western and southern margins; towards the north-east there is a decrease to under 10 inches. There are two distinct rainy seasons, the more important from July to September when some 43 per cent. of the annual rainfall occurs and a second period from December to March which receives some 35 per cent. of the year's rainfall. The summer rains are convectional, violent and shortlived, heaviest in the desert valleys, and are often accompanied by thunder and lightning. The winter rains are lighter and may last several days; precipitation is usually heaviest on the mountains and here snow may be deposited while the valleys are receiving gentle rain.

Wide ranges of temperatures and lengths of growing seasons are also to be found. Flagstaff, a plateau station, has a winter mean of 27·3° F. and a summer mean of 66° F., compared with Yuma's means of 52° and 92° F. respectively. In the lower regions daily maximum temperatures of 110° F. are not uncommon and no summer fails to reach 105° F. The expected maxima on the plateau attain 80° F. At low elevation stations the growing seasons are long and are associated with high mean temperatures; thus Yuma has a growing season of 326 days and Ajo 332 days, while an extensive area of the south and west has 300 days or more; Tucson has 248 days and Phoenix 295 days. On the plateau the length of the growing season is of the order of 100 days and this shorter period is associated with low mean temperatures. It appears that approximately 30 days are cut from the growing season for each increase of 1000 feet in elevation. The combination of heavier precipitation and lower temperatures on the mountains is of great economic significance since it promotes the growth of plants used for grazing and of trees for timber, and the rain also furnishes run-off into irrigation reservoirs. An important tourist industry too is closely related to the fact that most of the State receives over 80 per cent. of its possible sunshine. Further the relative humidity is amongst the lowest in the U.S.A., being 40–60 per cent. as

an annual average and it is not unusual, on hot summer afternoons, to measure relative humidities of 5 per cent. or less. These low humidities have helped Arizona to become a health resort for sufferers from sinus, rheumatic and pulmonary diseases and also a centre of winter and summer tourist traffic. The mild winter climate and abundant sunshine of southern Arizona afford escape from the rigours of a northern or eastern winter, and the magnificent variety of scenery in the Grand Canyon region of the Colorado provides the basis for a considerable summer tourist business there.

Water supplies. The heavier precipitation on the higher mountains, and the run-off from the melting of the winter snows, provide concentrated stream flows draining generally north and west to the Upper Colorado in the plateau area, and south and west to the Lower Colorado in the Basin and Range province. The drainage in this latter portion is by the Gila and its tributaries—the Salt, Verde, Santa Cruz, Agua Fria, Hassayampa—converging in the Phoenix area (see folding map) and here are the principal areas of water development in the State. Unfortunately the snows melt early, the rainy season terminates in March and the streams fail or become low from May to July; after the two months of summer rains, the streams dwindle again in September. Holdover of water from winter to summer, and from years of much rainfall to years of drought, is therefore necessary; and by means of high dams and surface storage reservoirs, floods that might otherwise have been lost are arrested and conserved.

The development of irrigation in Arizona has been continuous for more than half a century. In 1910 about one-third of a million acres were irrigated by diverting water from flowing streams. From 1910 to 1930 the development consisted principally of building storage dams on the Salt and Gila rivers and their tributaries, the largest of these structures being the Roosevelt Dam on the Salt river and the Coolidge Dam on the upper Gila. The storage system is so complete that for many years no water has run out of the mouth of the Gila river. Thus the Verde river has two dams, Bartlett and Horseshoe, with a combined reservoir capacity of 322,000 acre feet. The Salt river has a series of four dams, of which the largest is Roosevelt dam, with a combined reservoir capacity of 1,755,000 acre feet. The Coolidge Dam on the upper Gila river has a reservoir capacity of 1,200,000 acre feet. The average run-off of the Salt river, based on the twenty-five year period 1921–45, is 586,000 acre feet, of the Verde river 456,000 acre feet and of the upper Gila 286,000 acre feet, but because of the droughts that have afflicted the south-west during the last fifteen years there have been deficiencies in surface run-off which have coincided with a period of accelerated pumping from wells.

Since 1930 practically all new development in irrigation has depended on wells, and today more than half the water furnished to irrigated farms is pumped from ground-water reservoirs. The great natural ground-water resources are to be found principally in the alluvial peripediment zones of the Basin and Range portion of Arizona. The detritus filling the bolsons—boulders, gravel, sand, silt and clay—are coarser grained near the borders and finer grained towards the axes of the valleys. The older alluvial fill contained in the basins is, in general, an interfingering series of gravels, sand, silt and clay with the clay usually thickest near the centre of the basins as would be

expected from the conditions of their accumulation when the valleys were closed basins. It is the sand and gravel beds that constitute the principal aquifers. The hard caliche zones (calcareous hardpan formations) underlying most of the older valley floor deter downward percolation of water and little of the limited local precipitation percolates downwards to the water table, most of it being used by the vegetation or being evaporated. Thus the principal source of recharge for underground water in most of the basins is in fact derived from streams that drain the nearby mountains (Fig. 1). These side washes are normally dry and carry water only after storms or during periods when snow is melting; but although intermittent the streams often

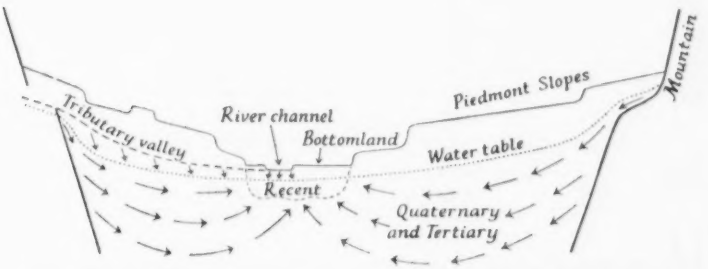


Fig. 1. Diagrammatic section of a bolson. The older alluvial fill, of probable Tertiary and Quaternary age, constitutes the major part of the material that occupies the bolsons. Sands and gravels of late Quaternary age (younger alluvial fill) lie unconformably upon the clays of the older alluvial fill. Aquifers in both groups are inter-connected so that the ground-water reservoir is continuous but the younger alluvial fill has the better and more numerous aquifers. Ground-water is derived mainly from seepage losses from surface flows in rivers and tributary washes, infiltration of water used for irrigation and underflow entering the basin at its upper end. Ground-water is discharged from the basin by pumping for irrigation, by vegetational transpiration and by underflow.

cut through the caliche floor and so the run-off, on leaving the hard rock of the mountains, infiltrates into the coarser alluvium in the piedmont zone.

It is on the withdrawal of ground-water from the alluvial basins that irrigation agriculture in Arizona increasingly depends. Ground-waters in the State are also pumped for municipal, industrial, livestock and domestic use, but quantitatively by far the greatest use of ground-water is for irrigation. It has been so used since at least 1900, but from 1935, and particularly since 1945, the annual increase in the number of wells drilled and in the withdrawals of ground-water for irrigation have been phenomenal. In 1946, the first year that records were collected from the entire area of development, the total withdrawal was 2,440,000 acre feet. In 1950 there were at least 4500 wells and 3,400,000 acre feet of water were withdrawn from the ground-water

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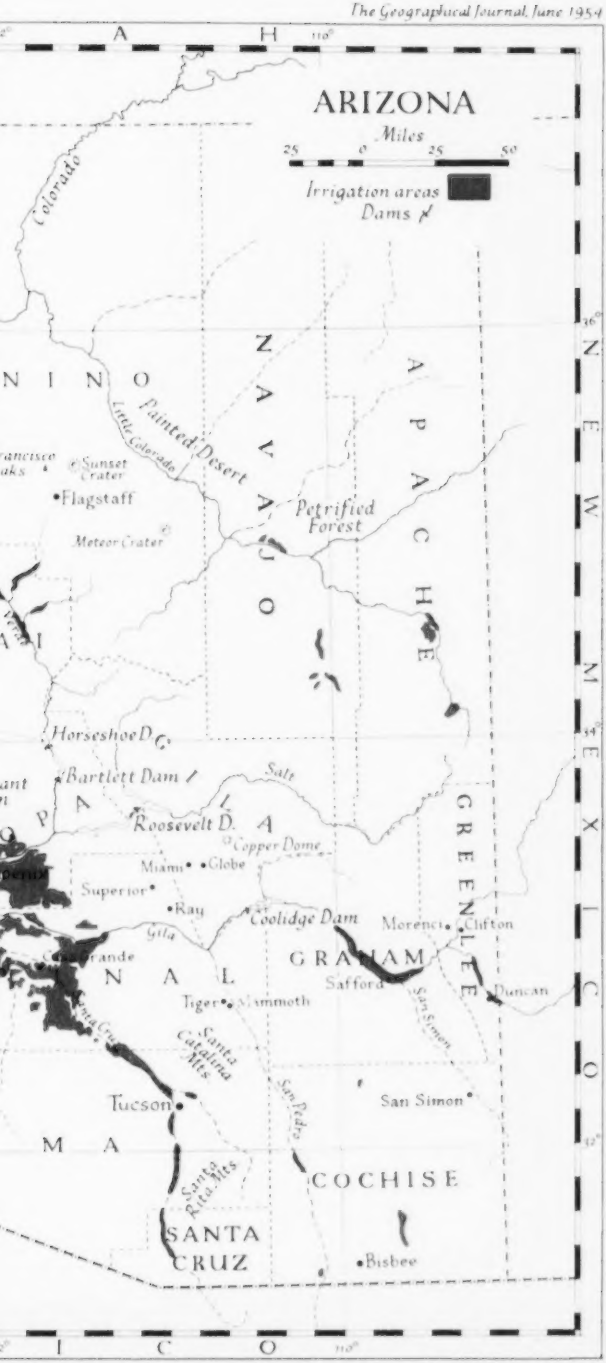

BARTHOLOMEW & PYE

reservoirs. This is more than the combined capacity of all the surface reservoirs and is about two-and-a-half times the average annual surface run-off of the Salt, Verde and Gila rivers.

The following table shows the increase in withdrawals of ground-water for irrigation in the areas most affected. These are the nine basins of the Gila river and its tributaries, *i.e.* the basins along the Gila, Salt, Santa Cruz and San Pedro rivers upstream from the Gillespie Dam on the Gila, to the New Mexico state line and the International border with Mexico.

Year	*Acre feet pumped*
1941	900,000
1942	1,639,000
1943	1,788,000
1944	1,738,000
1945	1,938,000
1946	2,293,000
1947	2,405,000
1948	2,934,000
1949	2,994,000
1950	3,178,000

A vital feature of the ground-water situation in Arizona today is that the rate of pumping far exceeds the rate of recharge. In some parts the annual rate of withdrawal is estimated to be at least thirty times the annual rate of replenishment. The records of water table fluctuations show that for many valleys the downward trend is continuous and is of the order of 5 feet a year in the Salt river valley, 8 feet a year in the lower Santa Cruz basin and some 2 or 3 feet in the other basins.[1] It is noteworthy also that since the alluvial materials generally become finer grained and more tightly cemented with depth, less water is yielded for each foot the water table is lowered. Hence as the water table falls the yield from each well diminishes and the cost of pumping an acre foot of water increases. The 1953 figures for the

[1] The downward trend of water levels has been accompanied by an upward trend in the dissolved solids content of the water. Recharge of the ground-water resources from surface flood flows was low in dissolved salts. As a result of reduced flow of the rivers—because of the conservation of water behind dams and its use upstream—the water recharged from infiltration of river water is more highly mineralized. From analyses it seems likely that a major cause of the increase in mineral content of ground water is the drainage from irrigated lands. This drainage water seeps downward, carrying with it some of the soluble salts that were contained in water evaporated or used by the plants; recharge from infiltration, therefore, causes a progressive increase in the concentration of dissolved salts. Lack of movement of ground-water away from the irrigated areas results in re-use of the same water several times, its concentration increasing with each use. Because only small amounts of dissolved salts can leave the basin the concentration of dissolved matter in ground-water is increasing. The excessive lowering of the water table and the increasing chemical concentration of the water both show that the safe annual yield has been greatly exceeded. There is no way of improving these conditions except by the addition of water of low chemical concentration. If additional water could be added provision should be made to ensure enough leaves the area to remove the excess salts.

cost of water were $13·50 for 3½ acre feet in the Salt river project, and in the Central Arizona pump areas 4 acre feet cost $26·00 for a 150-foot lift and $40·00 for a 250-foot lift. Although it is not possible to quote a maximum economic pump lift for irrigation, an answer can be approximated for the maximum availability of the ground-water resources. The following table gives a range of depth of wells in the irrigated areas, and since in general drilling has proved that little water can be developed for irrigation below the depths indicated in the table, these may be taken to represent the bottom of the effective water-bearing strata.

Basin	*Range of depth of wells (feet)*
Salt River Valley	300– 900
Lower Santa Cruz	300– 900
Avra-Altar	300–1,000
Upper Santa Cruz	100– 500
Upper San Pedro	100–1,000
Lower San Pedro	100– 900
Upper San Simon	100– 900
Lower San Simon-Safford	150– 200
Duncan	100– 200

In any estimate of the length of time that would be required to exhaust the amount of ground-water stored there are not only uncertain variables (such as the rate of movement of ground-water from the margins of the basins towards the pumped areas) but also there are two deductions depending on whether the average withdrawal of 1940–50 or that of recent years is used as the basis of calculation. If the former is assumed some thirty years would be required to lower the water table 100 feet below the level that prevailed in 1950. But if the calculation is based on the current rate of decline, and this would seem to be the more realistic basis, then only seventeen years would be required to lower the water table 100 feet below the 1950 level. Thus for the first time since man arrived in the south-west and began to drill wells the ground-water supplies are being seriously depleted and since water is the key to the greater part of Arizona's modern development no aspect of its economic life merits greater attention.

Agriculture and forestry. Under natural conditions over vast areas of Arizona only desert types of vegetation can survive. Moisture is the principal factor limiting plant growth and the production of crops has been rendered possible only by irrigation.

Soil characteristics greatly influence the feasibility of irrigating land and the yield of crops. Some of the most important characteristics of the soil are due to the hot desert environment under which they have been formed; thus the sparseness of vegetation has made them poor in organic matter; they are consequently light in colour and deficient in nitrogen, but they are rich in carbonates and alkali. The characteristics of the texture and mineralogical composition of the soils however depend largely on their location in relation to their sources.

The broad alluvial fans that emerge from the canyons and slope downwards from the base of the mountain ranges are steep near the mountains and gradually flatten out upon the desert plains. Their lower flatter marginal areas often merge with the stream terraces to form the mesas or bench lands that border the comparatively narrow areas of alluvial bottom lands in the valleys of the main drainage streams. The further the materials have been transported the finer textured they are and the greater is the possibility of mixture with material from other sources. The coarser textured materials from individual parent rocks lie high on the alluvial fan slopes; the finer textured materials of mixed origin are on the peripediment and alluvial plains.

Naturally the availability of water for irrigation has been the principal factor in determining which lands should be irrigated and water is available at least depth in the axial zone of the valleys. Towards the marginal parts of the basins the piedmont slopes are frequently deeply dissected by tributary arroyos. For irrigation it is essential to have almost level land. Unevenness of slope will lead to variable plant growth, whilst sidefall across the direction of water flow leads to breaking over the furrows. Uniformity of slope is also essential for uniform water penetration, though of course the grade will vary with soil type, a slope of 6 inches in 100 feet being appropriate for sandy soil whereas a fall of 1 inch in 100 feet suffices for heavy soil. Thus the bottom lands offering smooth, flat or gently sloping plains are the lands that can most easily be engineered for large irrigable fields (Plate 1). They are also the areas containing the best soils of the Pima and Gila groups. These are the most recent soils and so lack a definite horizon of lime accumulation or caliche; and their deficiencies in humus and nitrogen are easily corrected by growing alfalfa and by ploughing under the crop residues. The soils away from the alluvial bottom lands are older and often have a very definite hard caliche zone in the subsoil and their coarse texture makes them excessively porous. Such defects of texture and caliche are not easily overcome and many of these older soils have not been considered fit for development under irrigation. The geomorphological transition from alluvial bottom lands to coarser terrace soils is usually well defined by an escarpment; agriculturally the change is marked by a transition from rich green irrigated fields to either a sparse dry grass area or to a desert vegetation of creosote, cholla, ocotillo and prickly pear (Plate 2).

Practically all the agriculture in Arizona is located in the semi-arid valleys where either impounded or underground water is available, and it occupies some 1·5 per cent. of the State's total land area of 73 million acres (see map). The contribution to Arizona farmers' cash income made by the several agricultural items can be seen in Figures 2a and 2b. None either compares in importance with cotton or shows such significant changes in the State's economy, so they call for but a brief mention. Dairying has failed to keep up with Arizona's rapidly expanding population and an important reason for the relative decline has been that many former dairy farmers have abandoned the industry for the more profitable enterprise of cotton production. The number of dairy cattle in Arizona in 1952 was the same as in 1940 yet during the same period Arizona's population increased from 499,281 to 850,000. As a result

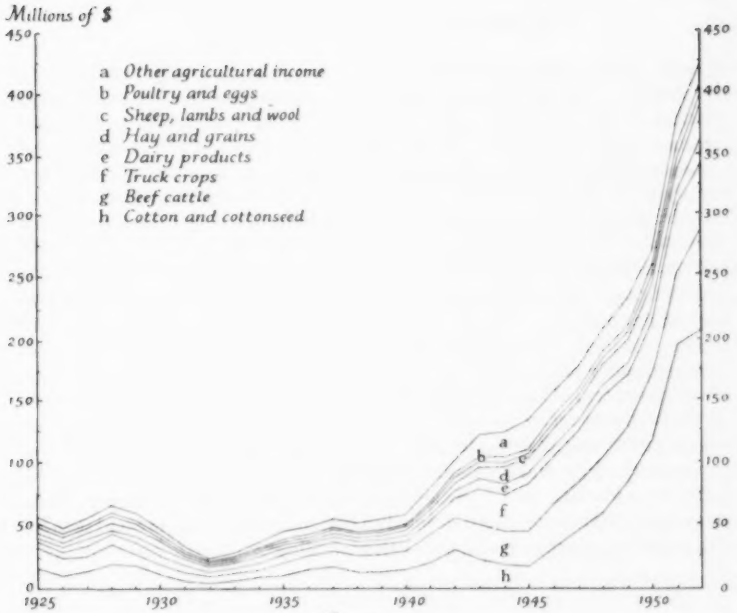

Figure 2a

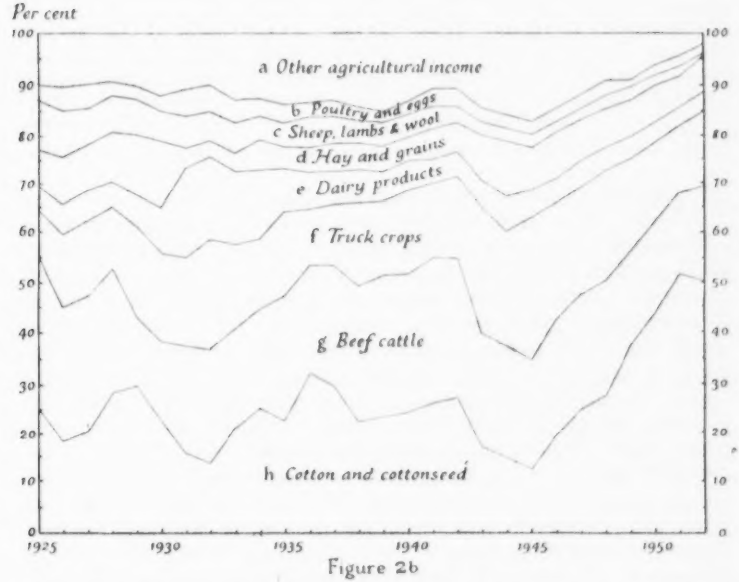

Figure 2b

Agricultural income in Arizona expressed by source: Fig. 2a in millions of dollars; Fig. 2b as a percentage of the total

The graphs are constructed cumulatively, i.e. the top of each band is the base from which the values for the next band are plotted

Arizona is now a deficit area as far as grade A milk is concerned and to relieve the shortage milk is imported mainly from California. Maricopa and Yuma counties are producers of vegetables and fruit, lettuce, grapefruit and oranges figuring most prominently. On the irrigated lands small grains, alfalfa and cotton compete for land, but whereas small grains and alfalfa are grown mainly for cattle feed and are not depended on as primary sources of cash income, cotton stands out above all other agricultural commodities as the main cash crop; it now supplies half the agricultural income and by 1952 over half the State's crop acreage was devoted to cotton. The long growing season and assurance of a stable water supply ensure ideal growing, ripening and harvesting conditions. Moreover it is readily marketable and if stored is good security for loans. It is noteworthy that cotton production over the years has been increasing at the higher elevations within the state and decreasing at the lower elevations. This decline in the lower valleys has been closely related to the hemipterous insect population but recent developments in Yuma province suggest that with insecticides and a more favourable price relationship of cotton to the fruit and vegetable crops production is being restored in those areas where it has once been abandoned. The table shows the acreage in Arizona's counties (see map) devoted to cotton for various years and demonstrates the spectacular increase in cotton plantings.

County	1920	1930	1940	1946	1948	1950	1952
Cochise	—	—	23	50	2,150	5,100	17,200
Graham	3,000	14,000	11,200	10,950	15,650	20,300	25,000
Greenlee	—	1,000	870	1,200	1,250	1,500	3,000
Maricopa	182,000	71,000	91,000	33,200	55,050	100,500	258,000
Pima	1,000	7,000	6,600	11,100	15,300	13,800	47,000
Pinal	9,000	44,000	39,500	85,000	127,000	127,900	261,000
Santa Cruz ..	—	—	—	600	800	1,100	4,800
Yuma	27,000	31,000	4,640	900	1,500	2,800	48,300
Totals	220,000	169,000	155,000	143,000	218,700	273,000	664,000

During the past two years the acreage has increased by nearly 400,000 acres. This has been achieved by the addition of about 275,000 acres of land not in cultivation in 1950 and also by a reduction in acreage of other crops, mainly alfalfa and feed grains. The increase in production per acre has been correspondingly notable. In the twenties the yield of short staple cotton in Arizona averaged 332 lb. per acre, in the thirties 436 lb., in the early forties 460 lb. and in the late forties 520 lb. In 1949 the yield was 650 lb., in 1950 825 lb., in 1951 741 lb. and in 1952 785 lb. Irrigated agriculture is naturally intensive because of the high water costs and other capital charges, but high yields are the rule since irrigation removes the great hazard confronting the farmer dependent on normal precipitation; there is in fact a nearly absolute control of growing conditions. Also contributing to higher yields were improved strains of seeds, insect control, more careful levelling of land with better water distribution and general improvement in cultivation practices. Arizona ranked seventh among the States in the amount of cotton produced in 1950 and 1951, whereas the State had ranked eleventh in 1945 and thirteenth in the period 1939–48. From producing just over 1 per cent. of the United

States cotton in 1941–6, Arizona is now responsible for nearly 6 per cent. Comparative figures for production in some other States are:

State	1951 *Acres*	*Bales of 500 lb.*	*Yield per acre* lb.
Arizona	555,000	860,000	741
Alabama	1,460,000	920,000	303
California	1,290,000	1,770,000	657
Louisiana	920,000	765,000	400
Mississippi ..	2,330,000	1,620,000	333
Oklahoma	1,450,000	450,000	149
S. Carolina ..	1,045,000	860,000	394
Texas	11,800,000	4,100,000	167

Arizona has attained the distinction of leading all other States in the amount of cotton produced per acre ever since 1949; the yields are nearly three times the national average.

Cotton production in Arizona is concerned with two types, Upland cotton and American-Egyptian cotton, though the former increasingly constitutes the bulk of the crop and most of Arizona is going towards one variety production. The American-Egyptian cotton is of importance in that it is the only source of long staple cotton in the U.S.A., but Arizona's industry has had a chequered career. Early attempts to grow Egyptian type cotton in the U.S.A. were unsuccessful until the development of the Yuma variety. In 1912 Arizona had 400 acres, in 1920 243,000 acres, in 1924 only 8000 acres and in 1929 there were 67,000 acres. The acreage then declined to 41,000 in 1939 but in response to war time demand this increased to 129,000 in 1942. Since 1943 acreages have again declined, averaging less than 6000 for the 1944–49 period, but rising in 1950 to 44,000 acres and in 1952 to 46,000 acres.

In choosing between the two competing types producers' decisions are guided by estimated relative returns. Involved in these estimates are such factors as the average yields of Upland and American-Egyptian cotton on the farm and the price of Upland cotton indicated by the futures quotations. Since 1930 the yields of American-Egyptian cotton have become increasingly unfavourable compared with those of Upland cotton and are now barely half as much per acre. To produce American-Egyptian on a parity with Upland would have required that the former should command higher and higher prices relative to Upland to offset the latter's increased yields; yet since 1930 the U.S. Department of Agriculture's entry into price support operations has raised the level of Upland cotton prices; the net effect has been to produce even more unfavourable conditions for the production of American-Egyptian in relation to Upland cotton. This, coupled with the fact that there is no organized commodity market in the U.S.A. for American-Egyptian cotton (and hence no effective guide to the futures price of this type) has resulted in the gradual decline of its cultivation. The future of the industry now appears doubtful for, although there is a large market in the U.S.A. for extra long

staple cotton, so long as Upland cotton is more profitable than American-Egyptian there is no incentive for the revival of the long staple industry.

Cotton has been harvested by hand as long as it has been grown as a domesticated crop and the harvesting is the last major agricultural process to be mechanized in the U.S.A. In Pinal and Pima counties the irrigated valleys lie east and north of the Papago Indian reservations and some two thousand Desert Peoples leave the reservations each year to work on the cotton harvest.[1] They occupy an important place in the economy of the cotton growing valleys and while harvesting the crop they are accommodated either in towns or in labour camps. Four-fifths of the cotton farmers in Pinal and Pima have these camps. Although the demand for labour has been greater than the supply for the past few years it is clear that the machine age is coming to southern Arizona quickly and with the swing to mechanization the labour demands will be increasingly for "skilled" Papagos. The mechanical pickers in the dealers' yards foreshadow the end of large-scale hand picking. About 310 mechanical cotton pickers were operating in Arizona in 1950; in 1951 nearly 900 were in use and it was estimated that 40 per cent. of the crop was mechanically picked that year; in 1952 nearly 2000 machines were engaged in harvesting the crop. The only difficulty in Arizona for machine picking is the heavy cotton foliage; in moister regions spraying with calcium cyanamide defoliates the plants and gives the picker a clean field, but in Arizona spray does not adhere well in the dry atmosphere.

Arizona is in territorial extent chiefly a range state, the lands used for grazing comprising some 62 million out of the total 73 million acres of land available. Grasses grow in all parts but they are most abundant and provide the most valuable feed between 3000 and 5000 feet (Plate 3). Here all the year round grazing is possible and some 20 to 40 acres are required to support each animal unit. Below 3000 feet the rainfall is too scant for good growth of grasses and only scattered bunches occur. Forage for livestock include mesquite and saltbush and the carrying capacity of the semi-arid range is low, up to 200 acres being required for each animal unit. Mountain range, above 6000 feet, can be used in summer, its value as range being secondary to its primary value as forest. The livestock industry supported by the range land is one of the foremost in the state being second only to cotton in Arizona's income (Figs. 2a and 2b). At present there are some 900,000 cattle [2] and 400,000 sheep, cattle having gained in importance and sheep having lost steadily since the 1920's. Arizona cattlemen manage to produce each year about 400,000 head for market. Of these some three quarters are shipped out of the State as live cattle, the remainder being slaughtered within

[1] The Desert Peoples pick the cotton as it is the most practical way for unskilled Papagos to earn cash for the satisfaction of their strongly felt wants. Their economy has changed from a food gathering, agricultural, hunting subsistence economy to a wage labour, agricultural, cash economy, and cotton harvesting represents about half the total cash income of the Papago.

[2] Hereford cattle are the predominant breed in the state but cattle of Brahman breeding have been introduced into Arizona during recent years in substantial numbers. They are being used particularly in the more arid sections of the state for crossing with the Hereford range stock to develop a climatically adapted animal that will still produce heavy veal or slaughter calves.

the State. Within recent years in response to the strong demand for fat cattle in California production of finished beef has become an established farm enterprise of major significance. The cattle and calves sold for beef and for meat packing have usually moved from the range lands to spend some time on alfalfa or winter grain pastures and then received a final fattening in the feedlots. Similarly the sheep, mainly owned by the Indians in the cooler parts of north-eastern Arizona, are pastured in the winter time in the valleys of southern Arizona. Thus farmers in the rich irrigated districts of the State are provided with an outlet for feed crops and a large measure of their economy is based on obtaining feeder calves and lambs from the range livestock producer.

More than one quarter of the land area of Arizona is classed as forest land. The forests cover the higher mountain areas and extend in a great arc from the north-west to the south-east of the state. Woodland timbers (4000–7000 feet) are juniper, pinyon pine and oak and are used for fuel and fence posts. Saw timber areas are those of ponderosa pine and generally begin at 7000 feet. These forests provide the raw materials for the forty or so mills of the state and are the chief support of Flagstaff.

Most of Arizona's crop production and livestock output is sold beyond its boundaries and moves into other states. Until the 1930's the chief concern of agriculture was with railway transport but during the past two decades Arizona, in common with other western States, has become very dependent on motor vehicles for the marketing of agricultural produce and for general commerce. The rapid growth in highway transport is evidence of the speed, adaptability and economy of truck haulage. As an indication of this increase it is estimated that there are in operation today three or four times as many refrigerated or insulated trucks and trailer units as there were just before the Second World War. Large areas of Arizona are more than 25 miles from railroads offering common carrier services and the areas are only served, if at all, by dirt roads. The importance of good paved roads is recognized, many have been built during the last twenty years, and others are now in process of construction. Good roads link the main towns and cities but these, of course, largely parallel existing rail routes.

Mining and manufacturing. The third traditional industry and major source of income of Arizona is mining. The principal mining districts occur within a belt of intense faulting, folding and igneous intrusions which lies south-west of a line through Morenci and Jerome and include the six large mining districts at Bisbee, Globe-Miami, Superior, Ray, Clifton-Morenci and Ajo. Bordering this belt on the north-east is the plateau of relatively flat-lying strata where chiefly non-metallics have been mined. Although the first important mining in Arizona was for gold and silver, during later years copper, lead and zinc have acquired primary commercial importance, and ever since 1887 copper has been Arizona's leading metal, with a production greater than that in any other state in the U.S.A. Zinc supplanted gold for second place between 1944 and 1950, and lead took third place over silver during 1945–50. Today Arizona is fourth in the production of silver in the U.S.A., producing some 12 per cent. of the U.S.A.'s total.

The former mining centre at Jerome experienced a bonanza period in 1916

but this area is now completely worked out and Jerome was finally abandoned in 1952 (Plate 4).

The output of copper for various years is, in short tons:

	1910	1920	1930	1940	1945	1950
Arizona	148,746	279,128	288,095	281,169	287,203	403,301
U.S.A. (total) ..	544,119	612,275	705,074	878,086	772,894	909,343

How long this impressive record of a production approaching half that of the U.S.A.'s total may continue depends primarily on the successful development of new ore bodies. As examples of known reserves may be quoted the 5000 million lb. of copper at Morenci and 7000 million lb. at the new discovery at San Manuel. This latter mine being developed between Tiger and Mammoth will involve the creation of a new city designed to house a mining community of 7000 people. These two districts alone have gross reserves amounting to more than 50 per cent. of all the total copper produced in Arizona prior to 1949.

Perhaps the most notable recent development in the mining industry has been the growth in the production of zinc and lead. In 1939 copper, lead and zinc prices began a long upward climb and in 1940 the zinc output was the largest in Arizona's history. Until 1949 there were successive new records of output of both lead and zinc, the Bisbee district yielding more than half the zinc and more than a third of the lead output. Approximately 85 per cent. of the total zinc and 57 per cent. of the total lead output of the state has been mined during the period 1934–49. Details of production for particular years are given in the table:

	1920	1930	1940	1945	1950	
Lead	6935	4246	13,266	22,867	26,383	(short tons)
Zinc	729	815	15,456	40,226	60,480	

It is noteworthy that the zinc and lead production since 1939 has come largely from ore bodies previously unknown or undeveloped. Arizona ranked fourth in lead production within the United States in 1950 and third in zinc in the same year, with approximately 6 per cent. and 10 per cent. of the total U.S.A. production respectively.

Since 1951 manufacturing has been more important than mining both in the numbers employed and as a source of Arizona's income. The comparative situation since 1946 is revealed in the following table:

	Employed in manufacturing	*Employed in mining*	*Value of manufacturing output* ($)	*Value of mining output* ($)
1946 ..	11,600	7,800	86,000,000	57,913,278
1947 ..	15,200	12,600	117,000,000	127,197,809
1948 ..	15,900	12,900	136,000,000	160,544,227
1949 ..	15,000	12,200	129,000,000	183,817,838
1950 ..	15,700	11,000	142,000,000	135,938,774
1951 ..	22,900	12,100	214,000,000	215,516,503
1952 ..	27,900	13,200	292,000,000	203,706,430
1953 ..	28,800	12,900	not available	

A part of the manufacturing employment is concerned with the working up of materials produced in the agricultural and mining industries. Thus in 1953 food and kindred products, timber and wood products and primary metal industries accounted for nearly half of those employed in manufacturing; but more than a fifth of the total is engaged in the manufacture of aircraft, aircraft parts and electronic equipment. The position of Arizona in relation to the Pacific seaboard and the international Mexican border were important considerations in the location of these defence industries in the south-west, and the considerable gains in these categories that occurred after 1945 are not expected to continue now that reductions are being made in aircraft and defence manufacturing.

The tourist industry. The last of the major sources of Arizona's income is the tourist business (Fig. 3). This has grown considerably during the last fifteen years and the state's climate and scenery and natural vegetation are the

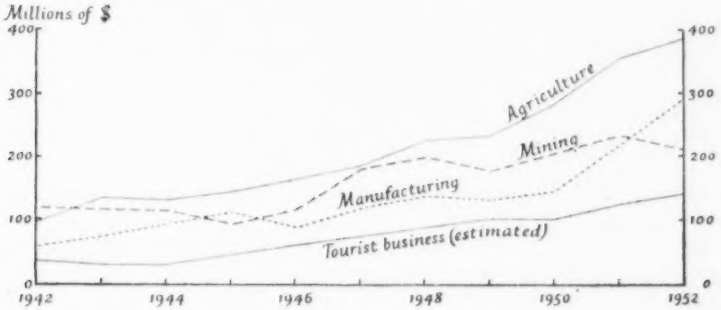

Fig. 3. A comparison of the relative importance of income from Arizona's principal sources

solid physical bases on which this industry has developed. The Grand Canyon, the Painted Desert, the Petrified Forest, the Meteor Crater and Sunset Crater all attract tourists to northern Arizona. In the southern part of the State the Organ Pipe Cactus and the Saguaro Cactus National Monuments, the Spanish Missions and the desert climate are the key factors. To speak of *the* tourist industry is something of an oversimplification for there are really two tourist industries, quite separate and distinct and developing contrasted characteristics. Thus the cooler northern region caters for the summer traveller and the warmer southern region serves the winter holiday maker. Moreover the northern part of the State offers one of the main approaches to the summer playgrounds of California and the tourist here is very often on his way to the west coast or he is moving east. In the winter season the southern part of Arizona includes the principal motor routes to southern California which, with Arizona and Florida, competes for the bulk of the American winter tourist business.

The contrasted nature of the seasonal pattern in northern and southern Arizona is demonstrated in Figure 4 which is based on the number of visitors

to National Parks and Monuments. It is convenient to depict the monthly seasonal record as starting in October because not only is this the month that best represents the beginning of the tourist year according to the National Park Service but it is also the month when the indexes for the northern and southern industries are equated. From this common starting point it is clear that southern Arizona rises to a peak of tourist activity in February and thereafter descends to a minimum in August, whereas the northern part of the state drops to its lowest point in January and rises to its peak in August, dropping away quickly during September and October just at the time when the southern business begins to show a recovery from its summer low. The close correspondence between seasonal activity for the north of Arizona and

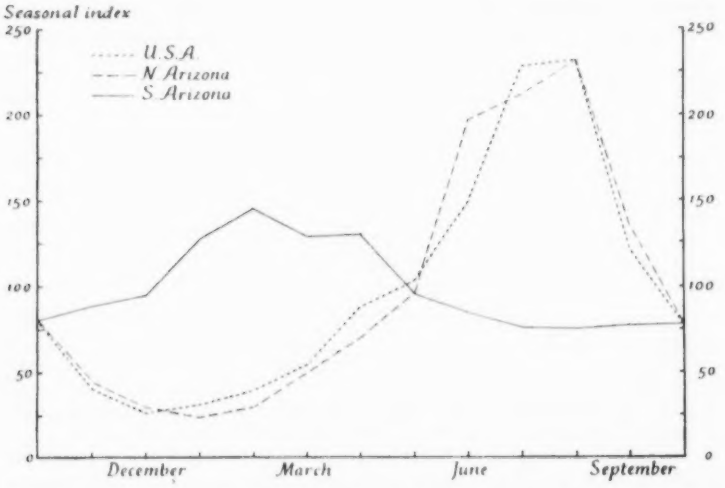

Fig. 4. Seasonal elements in the tourist trade of northern Arizona, southern Arizona and U.S.A. as reflected in visitors to National Parks and Monuments during the period September 1947–51. The seasonal index figures relate to an average month = 100

for the entire U.S.A. is accounted for by the fact that most vacation travel in the whole country as well as in northern Arizona takes place during the summer. That the northern part of the State is ahead of the national average in June is explained by the milder weather prevailing at Grand Canyon than at the several tourist centres further north; by July such places as the Rocky Mountain, Yellowstone and Glacier National Parks have thawed out sufficiently for tourists to be drawn in.

Although records of visitors to the National Parks and Monuments may provide a satisfactory index of tourist numbers the volume of tourist business in the State may not be sufficiently portrayed merely by these numbers. Whereas the tourist in the north is passing through and has a short stay, the

tourist in the south is typically one who has gone to spend one or two weeks or longer in some desert resort, motel or guest ranch. If consideration is given to the longer average length of stay by the visitor to the south and to the indicated higher daily rate of expenditure in that area, a more illuminating picture of the relative importance of the two parts of the State can be given in terms of tourist dollars earned. The estimates by the Bureau of Business Research in the University of Arizona are that southern Arizona now grosses about $125,000,000 annually in tourist revenues as compared with some $50,000,000 for northern Arizona. This compares with a total of only $30,000,000 for the whole state in the 1940's and in this business Arizona will clearly reflect the general prosperity and travel activity in the U.S.A. as a whole.

An integrated reflection of the several recent developments in the economic geography of Arizona is provided by the growth of population. Arizona is ahead of all other states in the U.S.A. not only in the rate of growth of incomes of individuals but also in its rate of increase of population. The State's total population during this century has been

1910	1920	1930	1940	1950	1953 (est.)
204,354	334,162	435,523	499,261	749,587	900,000

This expansion is impressive and it receives greater significance if we remind ourselves that water is the basic condition of life in this semi-arid land. As population increases so will the demand for water whether it be for direct use for domestic needs or for expanding irrigation development or for industry. But surface water supplies, dependent on rainfall, cannot be increased. Ground-water supplies are being depleted at a rate that alarms all thoughtful Arizonans. That forward-looking citizens have conceived a scheme for an annual supplementary supply of 1,200,000 acre feet of Colorado river water to central Arizona—a project that arouses the fierce opposition of south Californians on the grounds that Colorado river water is essential for their continued prosperity—and that Arizonans are prepared also to suggest schemes for bringing aqueducts from more distant wetter states, or even the possibility of pumping water from the Gulf of California, is at once an indication of the gravity of the problem and of the difficulty of its solution.

ACKNOWLEDGEMENTS

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DISCUSSION

Afternoon Meeting, 1 June 1953

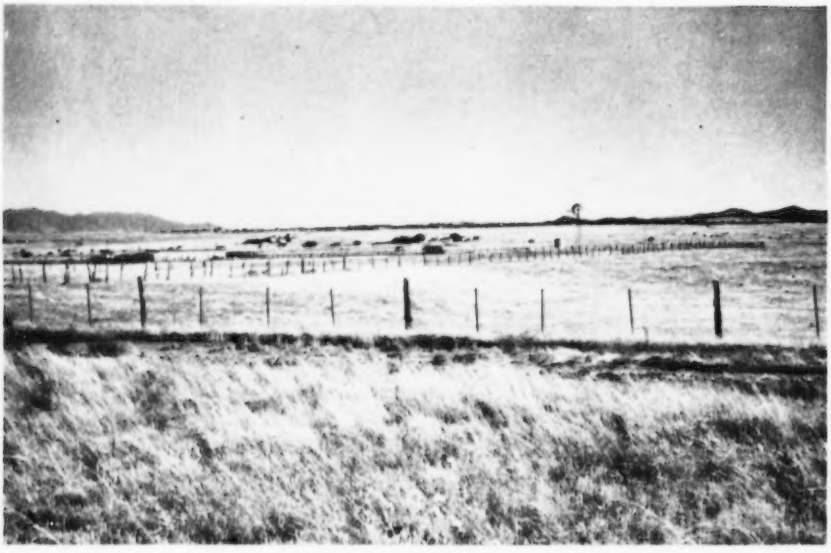
Introducing the speakers, the PRESIDENT (Mr. J. M. WORDIE) said: We are to have this evening a lecture on "Recent economic trends in Arizona." Mr. Pye will deal with the subject first and show a number of lantern slides, and afterwards, for about half an hour, we are to see a colour film, on which Dr. Balchin will give a commentary.

Mr. Pye then read his paper, which was followed by a film and commentary by Dr. Balchin.

The PRESIDENT: We must thank the lecturers for their kindly reference to the help of the Royal Geographical Society in making this study possible. We have also to compliment them on the excellence of the colour film. I wonder whether Professor Stamp would like to say a few words.

1. Young cotton, irrigated with ground-water, at Casa Grande

2. Cultivated valley bottom lands of younger alluvial fill in the Santa Cruz valley, clearly distinguished from the dissected bench lands that flank the Santa Rita mountains



3. Desert land grass near Sonoita (about 4000 feet). Such areas in the desert mountain ranges in Southern Arizona provide excellent cattle range country

4. Jerome, former prosperous mining centre, abandoned in 1952

Professor L. D. STAMP: I should like to congratulate the two speakers on the results of this expedition and to remark on the excellence of the amateur photography; this lecture has made me, and I think this audience, feel that we have really been to Arizona. It is eighteen years since my wife and I journeyed across the United States. I remember some of the roads on that occasion, and it is the more remarkable to see the excellent roads which have been portrayed on the screen. One might form the opinion that almost everything has now been done, but that would be erroneous. I was interested in particular in the references to and the pictures of the antique remains found in this region. Their preservation is a little more evident now than it was when I was there; they form a heritage very precious to the present generation. The lecturer has left us with the right impression, namely, that the answers to many problems in Arizona are not yet known. It is a country which has seen great development in cotton production during recent years, but one of its problems, not so far solved, concerns the conservation of the water. What is going to happen when that water-table goes down? I have seen what the Americans have done at the Agricultural College at Bagdad in the Middle East, but I wonder whether they have not yet an important contribution to make in this respect in their own country.

Professor S. W. WOOLDRIDGE: I cannot add anything to the debate, but I should like to take the opportunity of congratulating the two lecturers and to say how thoroughly I have enjoyed this film.

The PRESIDENT: Are there any questions?

Mr. J. H. PATERSON: Can the lecturer tell us of any actual examples in which irrigation projects have had to be dropped or taken out of operation because of the water level?

Mr. PYE: I do not think there is as yet any example of land going out of cultivation because water was not available. Wells are constantly being deepened.

The PRESIDENT: If there are no more questions it only remains for me to thank the two lecturers for their welcome contribution and to congratulate them on their originality in combining their separate contributions in this very interesting way.

THE WADI AZUM

MICHAEL BARBOUR

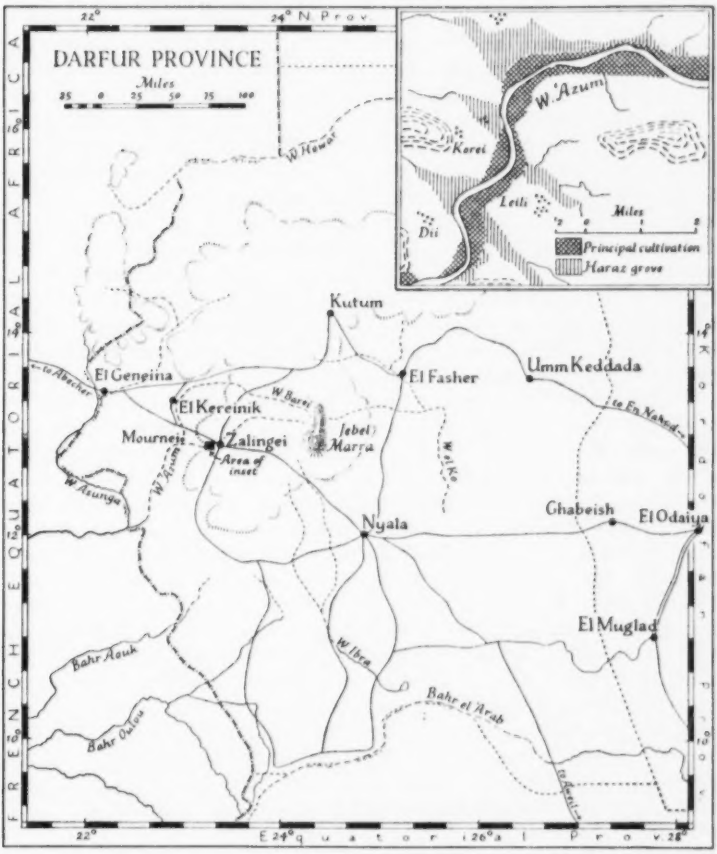
THE SEMI-ARID Sudan belt that stretches from east to west across Africa south of the Sahara includes portions of several political units, principally the Anglo-Egyptian Sudan, French Equatorial Africa, French West Africa and Nigeria; and these in turn include the territories formerly occupied by various famous African kingdoms such as the Fung, Darfur, Wadai, Kanem, Bornu, Sokoto, Timbuctoo, Songhay. Despite these divisions, and the rivalries that have accompanied them, there seems to have long been a remarkably free flow of men and ideas along the Sudan belt, and this flow continues today. In this part of Africa there is a striking correlation between vegetational and latitudinal belts, and the reason for this persistent movement at the same latitudes is presumably that to the north the lack of drinking water and of fodder has always restricted migrants, while to the south increasingly dense forest growth and tsetse and other noxious flies have made the passage of men and animals difficult.

The principal groups engaged in this movement have been in the past the Arabicized spreaders of Islam, such as the Fulani of the west or the Baggara (cattle-owning) and the camel-owning Arab tribes of the east. Today such groups, while still nomadic, are rather more stable within the modern political boundaries, and the most conspicuous movement of people is that of the migrants from throughout the Islamic areas who go on the pilgrimage to Mecca. The purpose of the following article is to describe an area which lies in the path of several of these streams of movement, and is subjected to a variety of influences. In attempting a fairly detailed account of the peoples' lives and their environment, the author hopes to show how the constant stimulus of fresh ideas and experiences has produced a remarkably rich pattern of society, with a considerable differentiation of function between its members. In particular it will be seen that a striking self-sufficiency has been achieved in the supply of manufactured commodities, not at the expense of variety, but by the maintenance and strengthening of indigenous crafts and skills.

The area in question lies in the Anglo-Egyptian Sudan, in the province of Darfur, not far from the border of French Equatorial Africa. Isolation is general in this region, and the whole of Darfur province suffers somewhat from its remoteness from the outside world, being far from navigable waterways and being joined to the railway system of the Sudan by surface by a 400-mile road over forbidding sand-dunes. Within the province the spread of western trade goods is still very restricted, and a reasonable supply of commodities can only be obtained in the capital at El Fasher and to a lesser extent in the administrative centres such as Nyala and El Geneina.[1] At the

[1] Until some thirty-five years ago Darfur was more or less independent, except for a short period between 1874, when it was conquered by the Egyptians, and 1898, when the grip of the Khalifa Abdullahi was relaxed. There was very little contact with the

centre of the province rises the volcanic mountain of Jebel Marra, 10,000 feet high, which with the streams that radiate from it forms a further obstacle to road transport from sources of supply in the east: to the south and west of this mountain lies the administrative district of Western Darfur, with its



headquarters at Zalingei on the Wadi Azum. It is with this area, lying somewhat to the south of the pilgrim route from French Equatorial Africa through El Fasher, that we shall be concerned, but by way of introduction it may be of assistance to recall some of the salient features of African geography at this latitude.

civilized world, except along the "Forty Days' Road" from El Fasher to Asyut in Upper Egypt: slaves, ostrich feathers and ivory were the principal exports, while the articles brought in exchange must have been few, and chiefly restricted to the Sultan and his court.

The province of Darfur lies between the parallels of 10° and 15° north of the equator, at a distance of over 1000 miles from the Atlantic Ocean, and almost equally far from the Red Sea. Structurally the region consists of a slight upwarping of the basement complex of Africa between the Chad and Nile basins; its mean altitude is between 2000 and 3000 feet above sea level. There are numerous granitic and metamorphosed "inselberge" which rise 200 or 300 feet above the plain, and in the centre of the province there is the volcanic mass of Jebel Marra whose summit attains 10,000 feet. On the flanks of this volcano there is a radial pattern of drainage, but the streams of the western side soon collect into two principal watercourses, the Wadis Barei and Azum, which meet before the Sudan border is reached and flow into French Equatorial Africa. The climate of the area is tropical, with marked continental features: winter's drought is most pronounced, and lasts from late October until April or May, while the summer rains are of convectional origin, extremely variable, and attain a total of between 10 and 40 inches. The eastern and northern parts of the province are the driest, the mountain and the adjacent areas to the west and south of it are rather wetter. In the north the vegetation is desert scrub, with drought-resisting acacias shading off into true desert; in the south there is short-grassed savannah, with broad-leafed species beginning to appear.

The presence of the mountain thus brings rather closer together than they would otherwise be the typical habitats of three main groups of Africans. To the north there are camel-owning nomads, mainly of Arab origin, in the centre there are settled cultivators, the almost negro Fur, and to the south there are tribes of cattle-owning nomads, unmistakable Arabs though fairly dark-skinned. The camel-owners are favoured by the sandy soils of their zone, despite the low rainfall and the scarcity of permanent water supplies, the cultivators make good use of the fertile basaltic soils of the mountain flanks and the silt terraces beside the wadis in their belt, and the cattle-owners find nourishment for their beasts in an area whose soils are generally too thin and stony for the growing of crops. The area where these groups come in contact with one another is the central one, where a permanent water supply is available throughout the year; in the summer of 1948, and again in January 1949, the writer travelled in the administrative district of Western Darfur, through which flows the Wadi Azum, the larger of the streams mentioned above. The portion of the Azum where conditions were studied in particular detail is that which lies downstream of the district headquarters of Zalingei, in a stretch of 55 miles as the river flows, as far as Murnei, where is the confluence of the Azum with the Barei. The Azum in this portion is a sand river 200 or 300 yards wide; in the winter it is dry at the surface, except when it crosses a rocky bar, where a pool or two may be found, but during and just after the rains a continuous stream is usual. (Such a flow is insufficient to wash away the stone and brushwood bridges that are laid across the sandy bed for the use of motor traffic, but at times it flows in spate and then circulation in the district by car or lorry comes to an abrupt end, to be resumed only when the bridges are rebuilt in October.) The main stream is flanked by alluvial terraces of sand and silt, giving a total width of about half a mile: these form the principal areas of cultivation, and their

Village and acacia scrub in foreground, in middle distance haraz groves flanking the Wadi Azum. Typical "inselberge" in background

Fur village with grain stores and thorn and grainstalk fences

Mountain Fur bringing salt to sell along the Azum

Weekly market in a haraz grove

proximity to the water table ensures for them a greater reliability than that of normal rain cultivations.

Further from the wadi on the upper terraces and on the sandy deltaic fans that have been laid down by the local streams there are conspicuous groves of *haraz* (*acacia albida*) trees, which in these favourable conditions grow to a height of 30 feet or more, with tall straight trunks and a spreading canopy above; these groves constitute a second area of cultivation, since the *haraz* loses its leaves in early summer, and thus does not prevent the growth of crops beneath it. Other benefits which it confers lie in the protection from erosion by heavy rains that it affords to the loose soils beneath it, and in the seed pods which fall in April and May and supplement the fodder of goats and cattle: in consequence it is little wonder that it is a protected tree, whose felling is generally forbidden, though this still occasionally occurs when a villager has seen a bee-hive out of reach or wants to make himself a hollowed-out mortar. Above the groves the country rises to a general stony plain about 100 feet above the wadi bed, and on this drier foundation the grass huts of the villages are built. The freedom from standing water among the houses after rain that results from the choice of such sites is held a sufficient compensation for the distance, half a mile or more, that the women have to go from their homes to draw water in the wadi bed; another advantage is that it is thus easier to keep domestic animals from straying among the crops. The immediate surrounds of the villages, and many of the larger compounds within them, are also used for cultivations, despite their stony nature; animals' droppings are collected to add to the fertility of this kind of field. Beyond the villages the poor stony ground supports a thin vegetation of thorny acacias and other drought-resisting trees, and short summer grasses; no permanent settlements occur, and the only cultivations are on patches of sand within reach of the villages, whereon rain crops may be grown. Rising above the plain are several of the "inselberge" already mentioned, whose levelled tops suggest the remnants of an earlier peneplain; these hills support a few trees and fairly dense grasses. Now quite uninhabited, they yield occasional finds of broken potsherds of an unfamiliar pattern, and of broken grindstones, indicating probably that they were an area of retreat for the villagers when conditions in the plains were less peaceful.

The settled inhabitants of the villages that flank the Azum and the other similar wadis of Western Darfur are known as the "lowland" Fur, to distinguish them from the "hill" Fur who live on the flanks of Jebel Marra. Racially indistinguishable, they speak mutually intelligible dialects of a common tongue. They are a black-skinned people, typical Sudanic negroes such as inhabit much of central Africa at these latitudes: there is an undoubted infusion of Hamitic blood which distinguishes them from the west African coastal negro. All profess themselves Muslims, but their general ignorance of Arabic, and the absence of an educated class, mean that the understanding of doctrine and the observance of the religious rules of life are uncertain. The glories of the Sultanate of Darfur, with its capital El Fasher and its sway at one time extending to the White Nile, are quite departed, and though a re-established Dimangawi—hereditary governor—is coming to be generally accepted within Western Darfur, there

are few remains of a native authority uniting the modern administrative districts.[1]

The Fur live in villages strung out along the watercourses, and subsist on the cultivation of rain crops during the summer: in the portion of the Azum below Zalingei a stretch of 55 miles supports 35 villages, with a total population of some 11,000 persons. (This constitutes about one-fourteenth of the whole population of the administrative district, whose total in 1948 was estimated at 153,000 persons in an area of 14,170 square miles.) The main crop cultivated is *dura* millet, which grows magnificently to a height of 14 feet or more and gives a reliable and heavy yield; on sandier soil *dukhn* or "bulrush" millet is grown, both because it tolerates drier conditions and for the improvement it makes in the flavour of native porridge. Other summer crops are sesame, chillies, *bamia* (*hibiscus esculentus*) and groundnuts: the first three are grown in small patches among the *haraz* trees and near the villages so as to be handy for day-to-day picking for use in stews, the latter on the sandiest soils near the wadi where the flowering stalks that are to bear the fruit can penetrate the ground easily. A supply of winter vegetables is obtained from small irrigated plots near the wadi; these are watered from shallow wells, and rarely exceed a square chain in extent. Onions are the favourite crop, and are generally eaten small and green; *bamia* is also grown but cannot resist the occasional frosts of winter and must be planted early to ripen before December or else be sown in February for consumption in May. In the more clayey areas considerable plots of cotton are sown, some "native" and some imported varieties: this is treated as a perennial crop and may be left in the ground for three years or more, so long as it continues to bear. Picking goes on more or less continuously throughout the year. A more recent introduction to the region consists of fruit gardens, largely the result of the example of the government garden at Zalingei. Citrus fruits and guavas are most commonly grown, and mangoes and bananas are being introduced slowly. The latter require protection from the frosts of winter by matting structures erected around them, and almost all the fruits need similar care while they establish themselves. These gardens are irrigated at first, but later the roots reach the water table and no further watering is necessary. Around Zalingei two special crops call for attention. The growing of irrigated potatoes in the winter is becoming a general practice, partly for local consumption amongst the eastern Sudanese officials but more especially for transport to El Fasher, where there is a considerable demand; secondly several more prosperous cultivators are growing tobacco in the winter, for eventual transport to Omdurman for the making of chewing snuff. This crop is planted out in sandy soils near to the wadi, and receives no irrigation: it requires care and skill to cure and dry it before it is taken to market, and with its lay-out of beds and drying sheds and its employment of hired labour, tobacco growing seems to be replacing peasant farming by a petty capitalism.

[1] The Sultanate of Darfur was founded in 1596 by Suleiman Solong, reached its greatest extent *c.* 1780, and was overrun by the Egyptians under Zubair Pasha in 1874. After the fall of the Khalifa Abdullahi in 1898, the Sultanate was revived by Ali Dinar, and persisted until 1916, when the Sultan joined the German-inspired Senussi revolt and was defeated and killed.

In addition to their crops the Fur are able to keep a wide range of domestic animals, and so may be said to practise a simple form of mixed farming; though no fodder crops are grown, *dura* stalks are grazed when harvest is over. Most villagers own a couple of head of cattle or more, and several goats and sheep; these are kept for milk and for eventual eating, and the value of their droppings (carefully collected from the enclosures in which the animals pass the night) is well recognized. Within the villages chickens and sometimes pigeons are kept, so there need be no problem of obtaining a mixed diet throughout the year.

A very different way of life is that of the Baggara, the cattle-owners, who migrate into the district from the east and south from December onwards: these proud nomads, with recent memories of military prowess during the Mahdiya, practice a very little cultivation during the summer and depend almost entirely upon their cattle to maintain them.[1] Most of the Baggara winter along the Bahr el Arab, to the south-east, where they come into contact with settled Dinka tribes, but a few groups of Bari Helba come regularly each year into Western Darfur. Their chief needs are water and grazing for their animals; they obtain grain and vegetables for themselves by bartering milk and butter with the villagers or by selling a beast to the butchers. They cause a little difficulty by pilfering grain and animals, and are rather loth to submit to the rule of Fur authorities.

The camel-owners from the north have similar needs, and differ chiefly in their willingness to seek employment as carriers of grain and goods for government or merchants. This is perhaps explained by the absence of the demand for camel's milk or flesh from whose sale they could pay for their day-to-day needs. The same difficulties of stealing and lack of control occur, especially since only a few members of each family make the winter migration, and the authority of their tribal chiefs is thus weakened; attempts at tax-evasion are frequent and individual migrants may come from far afield. Also from the north come a few Zaghawa tribesmen, cultivators whose water supplies do not last the winter: poorer than the Fur and less proud than the Arabs they settle on the fringes of the villages, and earn what they can by helping pick cotton or thresh and grind grain. They are less willing to depart at the start of the rains than the nomads, especially when several successive lean harvests have accentuated the poverty of their lands compared with those of the Fur.

A more constant type of immigrant is that of the loosely styled Fellata, westerners[2] from French West and Equatorial Africa and from Nigeria, of whom there is a community at Zalingei, finding employment in the tobacco fields and as porters and labourers in the market. Usually these persons are nominally on their way to Mecca; in fact immigration is readily permitted and many find the conditions and rewards of labour better than in their own

[1] When Mohamed Ahmed ibn el Saiyid Abd Allah (the Mahdi) successfully revolted against the Egyptian rule in 1881, the Baggara tribes of the western Sudan formed the backbone of his army. His successor the Khalifa was a member of the Taisha tribe of southern Darfur.

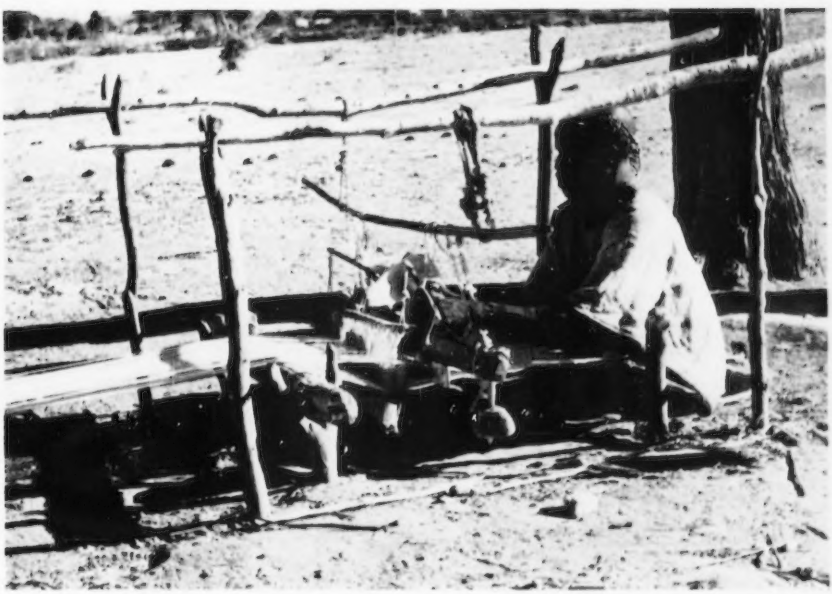
[2] An account of the distribution of the "westerners" in the Sudan is to be found in *Sudan Notes and Records*, vol. 33, 1952, pp. 60–112, by Isam Ahmad Hassoun.

homes. There are besides a few settled traders from the eastern Sudan, and numerous mendicant pedlars who regularly attend the village markets. A diminishing group are the hill Fur, who come down from Jebel Marra with coarse salt that they have evaporated from streams in the hills and trek as far as El Geneina on the Sudan border to sell it: the Port Sudan product is recognized to be cheaper and better. This decline of local salt production is of especial interest as a first instance of the victory of technical knowledge and modern large-scale production over the traditional crafts and self-sufficiency of the Fur. As has been mentioned above, Darfur is far from the sources of supply of manufactured articles, and Zalingei in particular is 166 miles from El Fasher over stony roads that soon wear out the lorries that use them: in summer moreover the wadi crossings are washed away, and transport is stopped until they can be repaired in mid-October.

Native crafts have thus had an exceptional opportunity of survival, and they still supply almost every need of daily life. From the cotton they grow the Fur carry out every process of cloth making: ginning—with a squeaky little hand gin; fluffing and cleaning—with a bow-like instrument; spinning —with a simple wooden distaff; and finally weaving on a hand-loom in strips about 10 yards long and 10 inches wide. The cloth is strong and durable, and a certain amount comes to market after families have satisfied their own needs; it is thicker and warmer than the cheap Indian cottons that the merchants peddle, and readily commands a higher price than the manufactured article. For footwear the villages have their tanners, working with local goat and sheep skins and with local tanning agents, and their slipper-makers, who probably buy their dyes and their needles from the pedlars, but who use knives and scissors made by the local smiths. These smiths until very recently smelted their own iron from ferruginous sands occurring in the hills, but nowadays they more often buy a broken lorry spring or axle as their raw material; they are to be found in most villages, squatting over a charcoal fire, making knives, spear-heads, scissors, hoes and other implements. These, though far below manufactured goods in quality, and probably a worse proposition economically, are nevertheless cheaper in first price than imported articles; another advantage is that the poor soft metal they contain can be more readily repaired or resharpened locally than can the tempered products of modern metallurgical skill. While regarded as members of a distinct group, the smiths are not of a different caste or tribe (as occurs in some other parts of Africa), and they have their own cultivations which they work in the rainy season in the interval of repairing broken hoes and axes for their neighbours. Closely linked with them (usually as their wives) are the women pot-makers, who use local clay and dung fuel to mould and bake water pots and cooking utensils; they work by kneading a lump of clay against a special type of rope matting, and attain a remarkable circular result. To some extent the lighter and less readily broken empty petrol can is coming to oust their products for water-carrying.

The occasion of a pot-bake, the opening up of the shallow kilns and the sale of the new pots, constitutes a picturesque but untypical manner of distributing local wares. Much of the most general method is to be seen at the markets, which are held at the principal villages once or twice a week,

Zaghawa women mixing dura porridge



Weaving native cloth on a home-made loom, from local thread

Women carrying baskets and gourds

Fur boys using a hand gin

and at Zalingei every day with an especial crowd on Fridays. At these there attends every villager who can find time from his regular occupation from within a radius of 15 miles or so (and in winter this means almost the whole population): Baggara come to barter butter and milk and perhaps a bull, pedlars offer cloth, needles and thread, razors and mirrors, sugar, tea and spices, charms and sandalwood; local women bring grain, cotton, some cooked meats for the traveller, and home-brewed beer to be drunk at the end of the day. There is little formal organization of markets, no payment of dues, but a natural separation seems to occur between men and women, and between Fur and non-Fur.

Apart from this method of redistribution of local supplies there are occasional winter treks made by groups of villagers as far as El Fasher or El Geneina; they carry loads of dried *bamia* and chillies to sell for the higher prices that obtain in the town, and take with them much of the food they will need on the road. Since those engaged would otherwise be idle, it is hard to judge whether these should be classed as excursions or as commercial undertakings. Such exports are rare however for the isolation that has preserved the Fur crafts and home industries operates equally against the prospect of regular exports of surplus agricultural produce. The tobacco and potato trade have been mentioned, and both are commodities which keep well in dry weather; the potential export of grain however is prevented by the ability of the environs of El Fasher to supply most of the province capital's demand, while the Government orchards established at Suni on the eastern flank of Jebel Marra will supply increasing qualities of citrus and other fruits more readily than the gardens along the Azum.

On the other hand, the very distance and inaccessibility of the modern pattern of civilization, cultural products, etc., mean that the lure of the towns, such as the rural areas of the eastern Sudan are increasingly experiencing, has hardly yet begun to be felt; few villages have more than one or two persons away in the east, or many more who have ever been beyond the district boundaries. In consequence the people's demands are correspondingly modest: western clothing is not coveted, tea is a recent innovation, and coffee is hardly consumed at all; metal teapots and Omdurman tea glasses are probably owned in most homes, but aluminium utensils are rare, and imported cutlery is virtually absent. As for the sewing machines, bicycles, or similar items of some elaboration and expense that are becoming increasingly common in the more sophisticated parts of Africa, few of the Fur have even heard of them. Nevertheless it should be plain from all that has been said that the Fur are able to attain a tolerably comfortable standard of living and a good level of nutrition, being protected from the ravages of internal strife and epidemics by the action of the administration, and from serious food shortages by reasonably plentiful rainfall together with the water available in the wadis. Certainly their conditions are more comfortable than those of the Baggara or the camel-owners, who for all their Arab pride are poor, backward and conservative, while the cultivators to the north of them frequently try to remain in western Darfur after the winter for the sake of the generally more prosperous conditions.

Such, then, is the economic interrelation between different population

groups in western Darfur, where a single region is occupied by persons with very different modes of life. This is of course not the only part of the Sudan belt where such a mingling occurs, and the interdependence of Fulani and Hausa in northern Nigeria springs to mind. What is perhaps the outstanding feature of our region is the large number of groups which meet along the Azum, so that between them an extremely full and varied economic life is maintained. For the future there seems no especial reason to expect any great change, unless some sudden find of mineral deposits were to transform the outside world's interest in western Darfur: the projected Omdurman–El Fasher road, when it is completed, will presumably reduce freight rates and stimulate trade, but until the total population and the national income in the Anglo-Egyptian Sudan as a whole shall have been multiplied several times, it seems unlikely that the pattern of existence by the flanks of the Azum will be much disturbed.

SCIENTIFIC ASPECTS OF THE EXPEDITION TO MOUNT EVEREST, 1953

L. G. C. E. PUGH

(*Division of Human Physiology, Medical Research Council*)

THE 1953 EXPEDITION to Mount Everest received scientific assistance which was more comprehensive and effective than that given to any previous British Himalayan expedition. Since the last British attempt on Mount Everest in 1938, much more had been learnt about human efficiency in extreme environments, and the results of the personnel research methods used with such great effect during and after the Second World War could be coordinated and applied to the many relevant problems. There was also the accumulation of knowledge from previous expeditions to Everest to be drawn on; and the experience of the Swiss party in the spring of 1952, generously made available by them, was of particular value. Further important information was derived from the physiological data collected on the British expedition to Cho Oyu in 1952. This expedition had been designed, partly with the object of climbing Cho Oyu (26,800 feet), the sixth highest mountain in the world, but mainly with the idea of forming and training a nucleus of climbers capable of attempting the ascent of Mount Everest the following year. A physiologist had accompanied the party* in order to study the effects of supplementary oxygen on men at high altitudes and also problems of nutrition, acclimatization and equipment. The expedition did not succeed in reaching an altitude greater than 22,500 feet but the information which was obtained made an important contribution towards predicting the requirements for the 1953 expedition.

Acclimatization.—The Cho Oyu party, like the Swiss on Everest, went straight up to high altitude within a few days of arrival in Sola Khumbu, and did not return to lower altitudes until after the attempt on the summit.

The party was insufficiently acclimatized, and lost a great deal of weight. They also suffered a high incidence of sickness due to diarrhoea and upper respiratory infections. It was thought probable that these infections were contracted from the local inhabitants and porters, and although hygiene could obviously be considerably improved, it seemed unlikely that the introduction of infection into a party on its arrival in the Himalaya could be altogether prevented. It was therefore urged that the forthcoming expedition to Everest should spend a month in the Sola Khumbu district in order to become acclimatized to altitude and to pass through the stage of initial infections before going on to the mountain itself. Experienced Himalayan climbers hold the view that little is to be gained by spending too much time below 14,000 feet when adaptation is required to altitudes above 18,000 feet,

* The attachment of Dr. Pugh to both the 1952 Cho Oyu Expedition and the 1953 Everest Expedition was made possible by successive generous grants from the Royal Society to the Himalayan Committee of the R.G.S. and the Alpine Club sponsoring these expeditions.

and this view is supported by the observation that Sherpas living at Namche (about 12,000 feet) complain of headaches and shortness of breath in crossing the Nangpa La at 19,000 feet. The plan was therefore adopted of spending three or four weeks on acclimatization, but instead of ascending by slow stages, the party should make short visits to heights of about 18,000 feet and return in the intervals to 13,000 feet to rest. This procedure proved extremely successful, and was thought partly to account for the greatly improved physical condition and freedom from illness shown by the party during the subsequent operations on the mountain.

Oxygen.—Oxygen had been taken on every expedition to Mount Everest except the reconnaissances of 1921 and 1951. The equipment available to prewar expeditions was still however insufficiently developed to be effective and it was not easy to persuade mountaineers of the usefulness of oxygen for their purpose. British parties in 1924 and 1933, and the Swiss in 1952, reached an altitude of about 28,000 feet by their own unaided efforts and were turned back by a combination of factors of which lack of oxygen was only one. Many mountaineers therefore thought (and some still think) that, given ideal conditions, Mount Everest could be climbed without the help of oxygen. Oxygen apparatus was however tried between 23,000 feet and 27,300 feet by Finch in 1922,[1, 11] by Odell in 1924,[4] and by Lloyd in 1938.[3] They each used open circuit apparatus weighing in the region of 28 lb. Finch and Lloyd, using 2·2 litres (NTP) of oxygen per minute, claimed increased speed of climbing and reduction of fatigue, but their companions climbing without oxygen, were not convinced that their own performance had been bettered. Odell, who used 1·0 litres per minute, obtained little benefit from his oxygen and found he went better on the whole without it. The conclusion generally drawn from the prewar experience was that the weight of the apparatus very nearly counterbalanced any benefit derived from the oxygen.[9, 10]

The experimental work done on Cho Oyu provided data permitting a reassessment of the oxygen problem. It became clear that higher flow-rates of the order of 4 litres per minute were needed and much more oxygen would therefore have to be provided than had been taken before. Although the net effect of oxygen on the rate of ascent of men climbing at 20,000 feet was found to be small, it was predicted that, given enough oxygen, above 26,000 feet the rate of ascent would be about doubled because of the elimination of the need for rests every few steps to recover breath. Because of reduction of fatigue, men would be able to do a much longer day with the help of oxygen than without it. The successful use of oxygen would however depend on the ability to overcome the practical difficulties of transporting adequate quantities of it to the higher camps.

Many people in both scientific research establishments and industry were concerned with the preparation of the oxygen equipment for the 1953 expedition. First a choice had to be made between the open and closed circuit types of set.

With open circuit apparatus the climber breathes in a mixture of air and oxygen and exhales to the atmosphere. The partial pressure of oxygen in the inspired gas mixture depends on the altitude, the air temperature, the

flow-rate of oxygen and the minute-volume of lung ventilation. At oxygen flow-rates of 2 and 5 litres per minute which are within the practical range for Mount Everest, a climber near the summit of the mountain inhaling 80 litres of air and oxygen per minute would be getting oxygen at a partial pressure equivalent to that of the oxygen in the atmosphere at about 22,000 feet and 13,500 feet respectively.

Closed circuit apparatus has two outstanding advantages. The climber breathes pure oxygen at a pressure even greater than the pressure of oxygen in the atmosphere at sea level. Secondly, loss of heat from the body via the lungs in warming and humidifying the inspired air is practically eliminated. This factor was considered important, for it was calculated that 50 per cent. of the total metabolic heat production of the body would be lost in this manner in men climbing at 28,000 feet at a temperature of $-40°$ C. ($-40°$ F.). Closed circuit sets are however more difficult to operate than the open circuit type and are liable to develop faults which cannot be identified and corrected under the conditions of use on a mountain. They had already been used in 1935 and 1938 without success.

Existing closed circuit sets designed for fire fighting and mine rescue are unsuitable for mountaineering use as they have neither the endurance required nor the capacity to handle the very high volume of lung ventilation needed in climbing at high altitude. If closed circuit sets were to be used, an entirely new design would have to be developed and it was doubtful if this could be done in the time available. The open circuit type was given first priority (on the advice of the Oxygen Advisory Committee under the Chairmanship of Professor Sir Bryan Matthews) on the grounds of simplicity and reliability, and because Finch and Lloyd had already shown that it could be used successfully under mountaineering conditions. However on account of the great potential advantages of the closed circuit type of set, some of these sets were produced for trial purposes and were taken on the expedition.

The amount of oxygen sent out to Nepal was 193,000 litres. This figure may be compared with the 29,000 litres sent out in 1922 and the 20,000 litres taken by the Swiss party in autumn 1952. Of the 160 cylinders containing the oxygen, seventeen were found to have leaked on arrival; one-third of the remaining 150,000 litres was used for training and a small quantity for experimental purposes. About 16,000 litres were left over at the end of the expedition; this would have been barely enough for a third assault. The climbers were carefully trained in the use of their oxygen equipment. They wore their masks for part of each day on the approach march, and made training ascents with both the open and the closed circuit sets. They also learnt to sleep comfortably wearing lightweight masks and breathing 1 litre of oxygen per minute.

Open circuit sets proved satisfactory apart from a few minor technical difficulties which were overcome and some trouble with ice formation round the mask and its connections. Respiratory resistance, which had always been one of the chief difficulties encountered in oxygen apparatus used on Everest, was reduced to a minimum even at high work rates. For strenuous work, 4 litres of oxygen per minute were needed, but men moving slowly behind a leader making tracks and cutting steps found 2 litres adequate. Using 4 litres

per minute, Hillary and Tenzing climbed at 630 feet per hour from 25,850 feet to 27,300 feet in a track prepared by their support party. The final climb from the top camp (27,900 feet) to the summit, when they only used 3 litres per minute (less than had been intended), took 5 hours.

The closed circuit sets were used successfully under the supervision of Bourdillon, who had been associated with their construction,[13] but even he found difficulty in tracing faults which developed on the South Col. He and Evans used these sets on the first assault and climbed nearly 3000 feet from 25,850 feet to 28,700 feet and back in a day. From 25,850 feet to 27,300 feet they averaged 930 feet per hour making their own track—this, for men carrying 50 lb. loads, must be accepted as an Alpine standard of performance. On the last 700 feet after changing soda lime cannisters, Evans' set gave trouble, but the fault was not identified. Above 26,000 feet the fact that the inspired air was warm and moist proved a great advantage, though at lower altitudes the closed circuit sets were uncomfortably hot.

The most important effect of oxygen was reduction of fatigue and high altitude deterioration. Climbers using oxygen found they could do a much longer day without becoming exhausted. Oxygen at night induced sleep and warmth, and promoted recovery from fatigue. All the climbers commented on the great subjective benefit experienced while climbing; they were able to enjoy climbing again and take an active interest in their surroundings. Climbing rates were not significantly improved up to 22,000 feet but above that altitude the improvement in climbing rate became increasingly apparent. Sudden failure of the apparatus while climbing caused severe breathlessness and weakness, although slow failure was apt to pass unnoticed. No ill effects were noticed on removing the mask, provided the climber first rested and recovered his breath. Hillary removed his mask on top of Mount Everest and was able to take photographs and set the shutter speed of his camera. After ten minutes he noticed his movements were getting clumsy and his thought processes muddled, so he replaced his mask. Bourdillon reported some loss of tolerance of altitude after wearing his closed circuit set for a prolonged period, but there was no evidence of this in the case of Evans.

Nutrition.—Himalayan expeditions have in the past usually subsisted on local foodstuffs supplemented from bulk stores taken out from England (or purchased locally). Below 10,000 feet, rice, *dhal* (a type of lentil) and *atta* (stone-ground wheat flour) are staple foodstuffs, and above 10,000 feet potatoes and *tsampa* (stone-ground parched barley) are eaten. Eggs and chickens are available in limited numbers up to about 13,000 feet and yak and sheep can be purchased between 12,000 feet and 14,000 feet and sent up on the hoof to 18,000 feet.

Most of the food for the day on a Himalayan expedition is consumed at two meals, breakfast and supper, and since the daily intake of Calories is 4000 to 4500—at least at the lower altitudes—these have to be very large meals. Very large quantities of tea are drunk, and with the serving of curry each evening and the strange, bulky diet, a considerable strain is placed on the digestive system. Digestive disturbances are relatively common, and cases of chronic diarrhoea occur which are probably of infective origin but are kept

going by an unsuitable diet. The majority of climbers however eventually become completely adapted to the diet and do well on it.

Cooking is done over wood fires up to 18,000 feet. Above that, fresh problems arise; the production of cooked meals and adequate quantities of liquid becomes increasingly difficult. Paraffin stoves are used, and all water has to be obtained by melting snow. Owing to the reduced boiling-point of water (176° F. at 20,000 feet), pressure cookers are essential if hot meals are to be provided. It is a curious fact that mountaineers have only recently come to accept pressure cookers as an indispensable part of their equipment; as recently as 1951, pressure cookers supplied free by the makers were discarded before the approach march.

Above 18,000 feet diet becomes unpalatable and monotonous. For this reason, and also because of the effect of altitude on the appetite, the food intake of the climbers becomes progressively reduced. Shipton,[8] on the 1935 expedition, obtained records of food consumed between 18,000 feet and 21,200 feet, and the calorific value worked out at between 1500 and 2000 Calories. At these altitudes, the food preferences of climbers undergo a marked change. They develop an increased appetite for sugar and, if sufficient quantities are available, may consume up to 14 oz. per day. The sugar is taken mainly dissolved in beverages, and these, in spite of their very large sugar content, seem to taste less sweet than at sea level. Climbers, while regarding the food provided as dull and unpalatable, often feel they would enjoy well-cooked food such as they would eat at home. Some men develop cravings for foods that are usually not available, such as salmon, sardines and tinned fruit.

Owing to the inefficient cookers and shortages of fuel, parties on Everest and other high mountains have usually had difficulty in satisfying their fluid requirements and there is much indirect evidence in Himalayan literature that parties have suffered from dehydration. This may also be because the sensation of thirst, like the appetite for food, may be impaired at high altitude, and men may suffer less from thirst than they would with a corresponding fluid shortage at sea level.

On the expedition to Cho Oyu in 1952,[5] the energy value of the diet on the approach march was about 4300 Calories, but intake fell to about 3000 Calories at and above 18,000 feet. This was higher than that reported by Shipton in 1935, probably because ample supplies of sugar were available. Between 5 and 7 pints (3 and 4 litres) of fluid per day were taken. Inconvenience and sometimes hardship were caused by shortage of essential stores due to pilfering and over-consumption of favourite items and to the difficulty of distributing and sorting the bulk rations.

In preparing the 1953 expedition, it seemed wise on general physiological grounds to avoid the sudden change to a strange and bulky diet and to provide a more varied and palatable diet than is available to a party living off the country. Some improved method for the sorting and distribution of rations was desirable and better arrangements for cooking and melting snow at high altitudes were necessary. At the high camps where economy of weight is essential, a special ration was needed which would provide a basic diet consisting largely of sugar, as well as catering for individual food

preferences. To meet these requirements it was decided to break with tradition and use composite rations of the type used in the armed forces for supplying troops operating in isolated groups or small units. Special stoves were designed to ensure an adequate supply of water at high camps, and pressure cookers were provided to make possible the cooking of meat and potatoes at and above the base camp (18,000 feet).

The organization of the packing of the rations was undertaken by the Army, and many of the items were made available from Army stocks. The detailed composition of these rations has been published elsewhere.[2, 6] In brief, two types of ration were taken:

(1) A general purpose composite ration packed in 14 and 28 man-day units. Palatability and variety were achieved by the use of tinned foods combined in a different menu for each day. Economy of weight was not a vital consideration in planning this ration, since there would be no shortage of porters in Katmandu at the time of the year when the party would be setting out from there. It was planned to supplement the ration with rice and potatoes purchased locally and later with fresh meat.

(2) An assault ration for use above 20,000 feet. In this every effort was made to economize on weight and bulk. No tins were used and most of the foodstuffs were vacuum packed. By vacuum packing, a soft item like a bag of granulated sugar is reduced to a hard rectangular block, which becomes soft again once the vacuum seal has been broken. This new method of packing offers very important advantages to all expeditions where economy of weight and bulk is important.

In order to cater for the personal idiosyncrasies shown by men at very high altitude, each climber was asked before the expedition to select one or more foods that he thought he would be able to eat at the high camps. These were packed in bulk and called luxury boxes. It was planned that each climber, before going high, should reject such items as he did not require from the assault ration and substitute the foods of his own choosing from the luxury boxes. At base camp the assault rations were further lightened by removal of superfluous protective wrappings and rejection of certain unpopular items such as pemmican and Service biscuits. The composition of the modified assault ration was then as follows:

Rolled oats	2 × 1 oz. packets	Boiled sweets	1 × 2 oz. packet
Milk powder	2 × 3 oz. packets	Salt	2 × 5½ gm. dispensers
Sugar	4 × 2 oz. packets	Cocoa	1 × 1 oz. packet
Jam	1 × 2 oz. packet	Tea	1 × 1½ oz. packet
Sweet biscuits	2 × 3 oz. packets	Soup	1 × 2¼ oz. packet
Cheese	2 × 1 oz. packets	Lemonade powder	2 × 1 oz. packets
Mint bar or banana bar	2 × 2 oz. packets		

Gross weight: 4 lb.

The above rations proved on the whole satisfactory. The general purpose composite rations were eaten at a greater altitude than had been anticipated (up to Camp 4 at 21,200 feet), and were supplemented with yak meat, mutton, rice and potatoes. The Calorie value of the diet eaten in the Western

Cwm between 20,000 feet and 21,200 feet was calculated to be about 3800 Calories per day, compared with 3000 Calories the previous year. During the assault, climbers ate most of the sugar and milk in their assault ration but otherwise subsisted on items such as sardines, salmon, cheese, tinned fruit and French saucissons from the luxury boxes, and Vitawheat, Knäckebrot and honey salvaged from the Swiss expedition of the previous year. Fluid and salt requirements were well met, and there was no evidence of significant fluid deficiency having occurred even during the assault phase.

The greater food consumption in 1953 as compared with 1952 is explained by better acclimatization, the provision for normal cooking at high camps and the improved palatability and variety of the food. It was generally agreed among the five men who had taken part in the 1952 as well as the 1953 expedition that the average level of fitness among the party at all stages of the expedition was higher in 1953 than the previous year. Objective evidence in support of this view is provided by the records of body weight. In 1953 the average loss of weight in the first month after reaching Thyangboche (13,000 feet) was 2 lb., whereas the average loss of weight over the corresponding period in 1952 was 11 lb. During the second month of the 1953 expedition, spent for the most part above 20,000 feet, the average loss of weight in five men for whom records are available was 4 lb.

Climatic considerations.[7]—On the expedition to Cho Oyu in 1952 climatic conditions were studied in relation to problems of protective clothing and equipment. The expedition experienced a wide range of climatic conditions, representing many recognized types of climate; for example, dry heat, moist heat, temperate alpine conditions, wet cold and dry cold. The snow-line from April to May extended down to about 17,500 feet, and it was only above that level that special protective equipment against cold began to be needed. The special features of the climate above the snow-line were fairly intense cold at night and low air temperatures combined with high radiation temperatures during the day. Weather conditions were variable: there were snow storms alternating with fine periods, but even in fine weather the onset of mist and snow in the afternoon was usual. Minimum temperatures at night at between 18,000 feet and 20,000 feet were variable and ranged from −13° C. to −20° C. (+8·6° F. to −4·0° F.). Sun temperatures of 69° C. (156° F.), measured with the black bulb radiation thermometer were observed in association with shade temperatures near freezing point. High winds were occasionally met with, but not of the force to be expected on ridges and cols above 22,000 feet. Although these conditions were not severe by comparison with those to be expected above 22,000 feet, the climbers complained of being cold in their sleeping-bags and suffered from cold feet while climbing. It seemed desirable that use should be made of modern technical developments in the design of protective equipment for cold conditions, due consideration being given to the special requirements for mountaineering which are an economy of weight, freedom of movement, and adjustability to suit variations in metabolic heat production and in environmental cooling power.

With regard to the question of cold on Mount Everest, no records of temperature were available from previous expeditions for altitudes above 24,000 feet. Balloon observations made at hill stations in India indicated that

minimum temperatures of −40° C. (−40° F.) and wind velocities of up to 100 m.p.h. were to be expected at 28,000 feet.[12] However the fact that mountaineers on Everest had not suffered more casualties from cold than they did suggested that, in the fortnight before the monsoon, temperatures were higher than at other times. By extrapolation from the Cho Oyu data, assuming a lapse rate of 3·5° F. per 1000 feet, minimum night temperature at the South Col at 26,000 feet would be between −25° C. (−13° F.) and −32° C. (−26° F.), and at 28,000 feet between −29° C. (−20° F.) and −36° C. (−33° F.).

Wind velocities of 100 m.p.h. would of course put a stop to climbing operations, since in a wind of such velocity even walking on level ground is impossible.

For climbing during the day in fine weather, climbers would have little difficulty in keeping warm as air temperatures by day would be considerably higher than the temperatures at night given above, and they would be gaining a large amount of heat by radiation from the sun. Conditions would however become extremely dangerous if climbers at very high altitudes were overtaken by bad weather or if they were benighted without their sleeping equipment.

Protective equipment—A single cotton-nylon fabric, chosen after extensive laboratory tests, was used in the construction of tents and windproof clothing. The outer windproof smock and trousers were greatly improved in design in the light of experience gained in 1952, and by making use of ideas from Polar practice. Particular attention was paid to the fit of these garments—this had been conspicuously at fault in 1952. The main insulating garments were the quilted down jacket and trousers which were similar to those used by British and Swiss parties the previous year. Silken inner gloves, woollen mitts and outer windproof mitts of ventile cloth were provided for protection of the hands, and a number of pairs of very large Swiss down mitts were taken for the assault parties.

Special boots were provided for use above 20,000 feet. These were of an entirely novel design, having relatively thin microcellular rubber soles and very thick kapok-stuffed uppers to provide the required amount of insulation. Both the inner and outer coverings were waterproof so that the boots conformed to the double vapour-barrier principle. This principle has recently been applied in the design of boots for the Allied forces in Korea. Much attention was paid to economy of weight since metabolic experiments have shown that 1 lb. of weight carried on the feet is equivalent to 4 lb. carried on the back. The boots were not entirely successful because they did in fact get wet (owing to tears in the outer covering), and this increased their weight considerably. In spite of the kapok being damp however the insulation afforded by the boots proved adequate for the conditions encountered. The total weight of the protective clothing, including boots and gloves, was 17 lb., compared with 23 lb. for a corresponding Polar clothing assembly.

Many different patterns of tent were taken. In addition to the British tents, American, French and Swiss patterns were taken for trial purposes, as well as a small experimental tent in which the normal tent poles are replaced by a spring steel frame which keeps the tent fabric under tension as in an

umbrella. The essential properties required in Himalayan tents are as follows: They must be quick and easy to erect and strong enough to resist high winds; they should be large enough to provide reasonable comfort for the number of occupants they are designed to shelter; very strong sewn-in ground sheets are needed to resist tearing when the tents are pitched on rock and ice. Ventilation is very important on account of the intense solar radiation during the day which raises the temperature even in well-ventilated tents to about 80° F. (27° C.); for this reason Himalayan tents should have entrances at both ends. Double walls for protection against low night temperatures are not necessary if the sleeping-bags and mattresses are adequate. Sleeve entrances as used in Polar tents provide a method of closing the entrances which will keep out draughts and wind-driven snow. Economy of weight is important but not an overriding consideration, except in assault tents. Of the tents used on the present expedition the modified Meade tents were the most popular and were used on the South Col and in the top camp. These are extremely easy to erect even in a strong wind. The other general purpose tent, the pyramid tent, was a modification of a pattern developed in 1943–4 for snow and mountain warfare and, though very light in weight relative to the number of men accommodated, suffered from the disadvantage of being difficult to erect in a strong wind. It was unfortunate that one of these tents was taken to the South Col.

Sleeping-bags designed for the Himalaya must have an outer and inner compartment to cover the wide range of climatic conditions encountered. About 8 lb. of down are needed to afford sufficient protection for temperatures down to −40° C. (−40° F.), and the inner bag should weigh about 3 lb. The bags should be long enough to pull over the head and wide enough to allow a man to turn over inside the bag, to which end a slippery nylon lining is an advantage. These requirements were met in most of the bags supplied which were of Canadian, New Zealand and British manufacture, but the briefing of the makers was in some instances incorrect. Sleeping mats were of the inflatable type. An ordinary commercial pattern was taken for use up to base camp. At base camp and above, special mats were provided, based on a design developed during the War which gives better insulation and eliminates the characteristic bouncing effect experienced by a person lying on the ordinary type of mat when he turns over. The special mats had a double layer of inflatable tubes which were constricted at the ends, thus buffering sudden displacements of air from tube to tube. These mats provided good insulation from the ground and were very comfortable. The descriptions by the climbers of their experience on the South Col indicates that they suffered rather severely from cold. This was explained by the fact that in order to save weight they left behind the inner components of their sleeping-bags. Had temperatures of −40° C. (−40° F.) instead of −25° C. (−13° F.) been encountered, their situation would have been dangerous.

The role of science in relation to the 1953 Everest Expedition, of which some account has been given in these pages, has been to reduce the stresses imposed by an extreme environment, to increase the climbers' ability to

maintain themselves under extreme conditions and so to preserve a state of health and efficiency sufficient to enable them to achieve their object. From the scientific, as well as from other points of view, therefore, the ascent of Everest is another milestone in the progress of man's conquest of his environment.

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DEPTH OF POLAR ICE CAPS

J. J. HOLTZSCHERER AND G. DE Q. ROBIN

GREENLAND

J. J. Holtzscherer

THE EXPLORATION of glaciers by the seismic method originated some twenty-five years ago, after seismic methods had been introduced for prospecting. The first experiments on ice were carried out in the Austrian Alps,[1] and the results obtained were sufficiently encouraging to suggest that this method might be used to obtain information on the thickness of a glacier or a polar ice cap. It was Alfred Wegener who first applied this new method to the measurement of the inland ice during his expedition to Greenland in 1929–31.

The areas chosen by the Expéditions Polaires Françaises (an organization founded in 1947 for scientific research and exploration) were Greenland in the Arctic, and in the Antarctic, Terre Adélie; and from 1948 to 1952 active work was in progress in both these areas. In Greenland, the research station was situated in the central part of the ice cap and was manned on a permanent basis for two years (1949–51), and in the course of five summer seasons an important scientific programme was carried out.

Thanks to the evolution of transport and to the possibility of air support, the E. P. F. were able to pursue, on a far larger scale, the work embarked upon twenty years earlier by the pioneers of the Wegener expedition.

Before recounting the principal scientific results of our researches, I must pay a tribute to my chief and comrade Alain Joset, Head of the Geophysical Section of our organization. Alain Joset was lost in an accident on 4 August 1951 with Jens Jarls, a Danish engineer, in a crevasse on the inland ice, while supervising one of two parties carrying out seismic soundings.

Seismic measurements.—The object of the team engaged in seismic soundings was to determine the thickness of the inland ice along different profiles, and to secure information on the physical characteristics of the ice both on the surface and in depth, and also of the sub-glacial floor.

The simplest as well as the quickest way of determining the thickness of ice is by the method of reflection. But the use of this method necessitates the most precise knowledge possible of the velocity of propagation of the seismic waves at all levels in the ice and firn. In Greenland this velocity varied slightly at different stations. The study of different waves and of the variation of their velocities was undertaken at different localities on the ice cap by refraction shooting on long profiles up to shot distances of 12 kilometres (Camp VI); and, when circumstances permitted, by seismo-soundings in boreholes.

Statistics of measurements.—During three summer seasons in Greenland in 1949, 1950 and 1951, the E.P.F. had two sets of seismic equipment in the field. Thus two groups were able to work independently. In March–April

1951, before the opening of the summer season in Greenland, Joset made some seismic measurements in Iceland on the Vatnajokull. In the summer of 1952, a team of the E.P.F. worked in collaboration with the American authorities and, starting from the base at Thule, was able to make some measurements in the northern part of Greenland.

The map (Fig. 1) shows all the routes taken by the seismic teams between 1949 and 1951. More than 8000 kilometres were covered across the inland ice and depths of ice at nearly 400 points ascertained, measurements having been made by reflection shooting at an average interval of 20 kilometres. Refraction shots were made at several places on the inland ice, in particular at Camp IV, Camp VI and the Central Station. The situation of these points (Fig. 1) is some indication of the significance of these measurements:

Camp IV—Altitude 1096 m.: in the ablation zone.

Camp VI—Altitude 1598 m.: above the firn line.

Central Station—Altitude 2994 m.: in the central part of the inland ice.

Reproduction of seismograms.—As an example, Plate 1 shows some seismograms recorded at Camp VI in 1950. These indicate clearly the different characteristic waves, which are as follows:

Direct longitudinal waves (P); transverse waves (S); surface waves (L); longitudinal reflected waves (R).

The letter O marks the moment of explosion. The recordings in Figure 2 are for shot distances from 150 to 2400 metres at 50-metre intervals. The arrival times of the first three waves seem to be straight lines at different inclinations, while the propagation times of the reflected waves (R) follow a hyperbola which approaches the straight line of the longitudinal (P) waves asymptotically. The rapid fading of the first longitudinal waves in relation to the distance may be noticed, despite a progressive increase in the explosive charges.

Results of refraction shooting.—Camp IV (Fig. 2): the travel-time curves for the different waves recorded show the direct longitudinal, transverse and surface waves, and two refracted waves in the layers beneath the inland ice.

The first of these refracted waves has a velocity of about 4800 m/s, which represents a value half way between that of the ice (3800 m/s) and that of the underlying rock. It seems that between the ice and the solid rock there exists an intermediate layer which may consist of morainic material. The presence of these two superimposed layers is confirmed by the travel-time curves of the two reflected waves. The velocity (6000 m/s) attributed to the solid rock is very close to that frequently measured in gneiss.

As the velocities ascertained by refraction shooting in opposite directions are almost the same, one may take their average in calculating the thickness. Thus we find at Camp IV a thickness of ice of 600 metres, in which the propagation velocity attains 3800 m/s, and a thickness for the intermediate bed of 250 metres, giving a propagation speed of 4800 m/s.

Camp VI (Fig. 3): The travel-time curve of the P wave shows, for both directions of shooting, that it very rapidly reaches its maximum velocity of propagation, namely 3850 m/s. Under the ice, which in this station is some 1370 metres thick, may be found an intermediate layer which shows a true velocity approaching 5000 m/s for a thickness of 300 metres. Under this layer

is a zone with a propagation velocity of 5450 m/s; this last layer seems to rest upon a fourth zone showing a speed of 6650 m/s, this speed being characteristic of the basic rock. It may be noted that the speed in the fourth bed is only known in a single direction of shooting, and it is possible that the high figure may be only an apparent speed. It is also relevant to point out that there is an important outcrop of basalt in Disko Island, 200 kilometres to the west of Camp VI.

Central Station (Fig. 4): The travel-time curves of the P wave show the increase of the propagation velocity with distance through the firn and ice, up to a maximum value. The transverse waves (S) and the reflected waves on the sub-glacial bed appear clearly, even showing double and triple multiple reflections.

Because of the great thickness of the ice (3000 metres) it would have been necessary to carry out shooting over distances of about 20 kilometres in order to obtain the travel-time curve of the wave refracted in the underlying bed. Such an undertaking was beyond the resources available.

The mechanical boring carried out at the Central Station showed that at the limit of depth reached (150 metres) very hard firn at a temperature of −28° C. was found. The hardness of the firn increased very quickly with the depth. The travel-time curve in the firn shows a continuous increase of propagation velocity in relation to shot distance; that is to say, in proportion to the depth attained by the seismic waves on calculating increased speed with depth, one finds that below 400 metres depth, the P waves travel at their maximum speed of 4000 m/s (Fig. 5). Taking into account the variation of the speed in these first 400 metres and assuming that for the rest of the thickness of the ice the speed remains constant (4000 m/s) one arrives at a mean speed of 3950 m/s.

Average speed of longitudinal waves.—At Camp VI, it was possible to use bore holes to compare the mean vertical speed of the P waves (seismo-soundings) with that obtained by calculating the depth of penetration of the seismic waves from horizontal shooting. Results were as follows:

Depth	*Seismo-soundings*	*Calculated value*
0–15 metres	2140 m/s	2175 m/s
0–25 metres	2270 m/s	2320 m/s
0–35 metres	2500 m/s	2460 m/s
0–45 metres	2700 m/s	2700 m/s

By taking account of the variation in propagation velocity in relation to the depth reached by the seismic waves, it is possible to use a mean speed determined in relation to the altitude of the measuring post, for the calculation of the thickness of the ice. The values adopted are contained in the following table:

Altitudes	*Speed*
below 2000 metres	3800 m/s
between 2000 and 2400 metres	3850 m/s
between 2400 and 2800 metres	3900 m/s
above 2800 metres	3950 m/s

Measurements show that the speed of propagation of seismic waves in ice increases as the temperature decreases. Thus one finds for:

Ice at 0° C.—speed—3600 m/s (temperate ice).
Ice at −17° C.—speed—3830 m/s } Polar ice
Ice at −26° C.—speed—4000 m/s }

A closer study of the speed variations of seismic waves might indirectly provide information on the temperature of glaciers, a glaciological problem of the greatest interest.

Results of reflection shooting.—Shooting methods: covering the region of the inland ice one finds several types of surface: (1) Bare ice—coastal zones, below the firn limit. (2) Compact firn—interior of the inland ice above the firn line.

In the majority of cases, in the central region of the ice cap (section 2 above) shot distances of 500–600 metres were used. The object of this method was to allow the reflected wave to arrive after the surface waves which fade out rapidly in the firn. In this way, the reflected wave arrives at a relatively calm portion of the record and, if the reflecting surface is satisfactory, it can quite easily be identified (Plate 2a). For shooting on ice (section 1 above) the records are much blurred because the surface waves fade out so slowly. In general, shooting was carried out at a distance decided by tentative methods and equal to about 1·5 times the presumed thickness of the ice. In this case, the arrival of reflected waves occurs between waves (P) and (S), namely before the blurring caused by the surface waves (Plate 2b).

If the reflecting surface is good, the energy may be sufficient to allow the recording of waves from multiple reflections.

Thickness of the inland ice.—The calculation of the thickness of the ice along the different routes enables outline sketches to be made of cross sections of the inland ice. Information is thus provided on the thickness of the ice cap and on the structure of the rock surface beneath the ice. Two profiles are reproduced here (Fig. 6) from which results may be summarized: one running approximately west–east, and another north–south, as indicated in Figure 1.

The inland ice of Greenland is shaped like a lenticular mass, bordered to the west and east by mountain chains. On the whole, the mountains of the east coast are higher than those on the west. The west–east profile of the inland ice shows that chains of mountains extend under the ice for a distance of about 200 kilometres, then give way in the centre to a sort of peneplain 400 kilometres wide, approximately at sea level (±200 metres). The average thickness of the ice along this profile is 2300 metres. The maximum thickness measured in Greenland is 3300 metres; this point is to be found about 100 kilometres to the north-east of the Central Station, in the area corresponding to the central dome of the inland ice.

The west–east profile studied further north (79°) near Thule shows a relief similar to the one already described, and an equally characteristic basin form. As the altitudes of the surface along this profile are lower than in central Greenland, the ice thicknesses are smaller with a mean value of 1500 metres.

The north–south profile shows that the rock surface persists in the neighbourhood of sea level as far as 67° N. South of this point, the rock surface

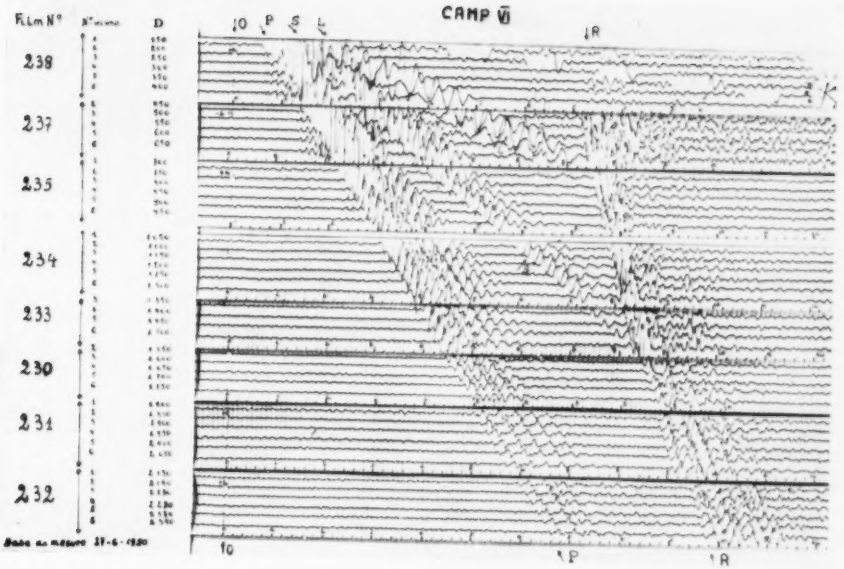

Plate 1

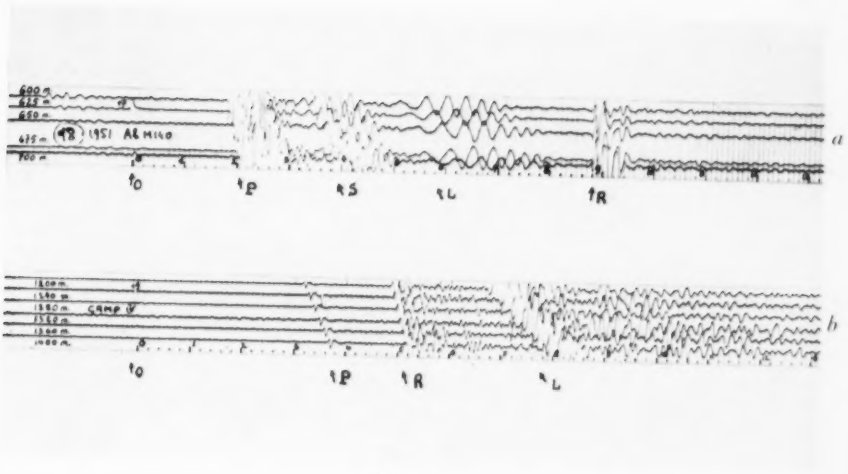

Plate 2

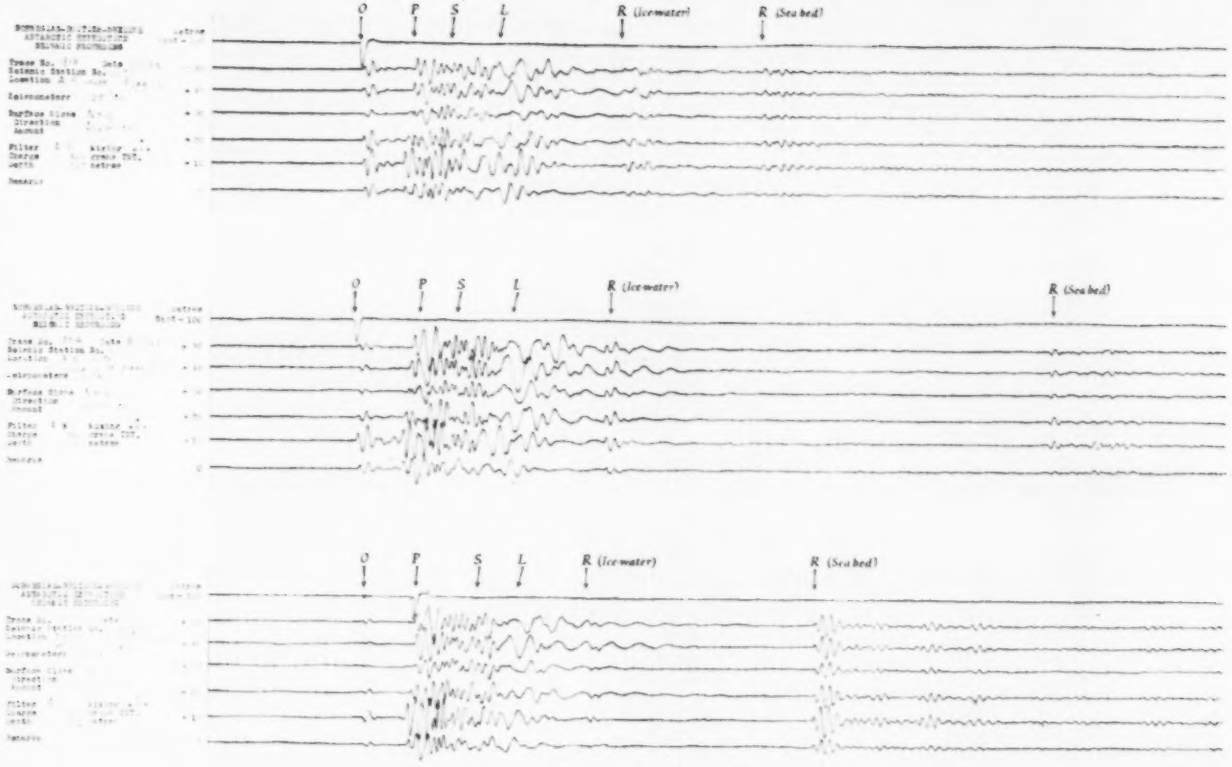
O
P
S
L
R (ice-water)
R (Sea bed)
O
P
S
L
R (ice-water)
R (Sea bed)
O
P
S
L
R (ice-water)
R (Sea bed)

Plate 3

rises, and then stays at an altitude of about 1000 metres above sea level. In this region the large flat-bottomed basin found further north appears to give place to a more irregular mountainous zone. It would seem that a direct relation exists between the position of the southern dome of the surface of the inland ice and the presence of the sub-glacial mountain massif.

Using the data on the thickness of the ice derived from the southern half and part of the north of Greenland, an attempt has been made to calculate the volume of the inland ice. This works out at $2{\cdot}7 \times 10^6 \mathrm{Km}^3 \pm 5$ per cent. The mean value for the thickness of the inland ice of the whole of Greenland must be around 1600 m.

DRONNING MAUD LAND, ANTARCTICA

G. de Q. Robin

While the work described by Monsieur Holtzscherer was being carried out in Greenland, a similar project was being attempted by the Norwegian–British–Swedish Antarctic Expedition 1949–52. Some preliminary work to test methods and equipment was carried out between April and December 1950, when other activities permitted. But the main project of running a line of soundings from the coast to the inland ice plateau of Antarctica was accomplished from October 1951 to January 1952. This was done by a party of three men with two vehicles (one abandoned according to plan), one dog team, and one set of seismic equipment. Air support was not practicable.

Due to these limitations, the work was concentrated on seismic reflection shooting measurements of ice thickness.[2–5] Some refraction shooting measurements were made to determine the velocity of sound in ice and firn; but, due to limited quantities of explosives, these were not as extensive as those described in detail by Monsieur Holtzscherer. The results obtained are shown for comparison.

Date	*Seismic Station No.*	*Distance from Maudheim: kilometres*	*Height above sea level: metres*	*Mean annual ice temperature surface ° C.*	*Velocity of "P" wave m/s.*
13.10.51	38 (Maudheim)	0	37	−17	3760 ± 20
13.12.51	165	185	480	−19	3775 ± 20
13.11.51	97	413	1575	−27	3785 ± 20
25.11.51	119	615	2710	−40	3810 ± 20

The maximum distance from shot point to seismometer used for this work was 1400 metres in each case, the corresponding depth of penetration of the seismic waves being 100–150 metres. The values agree quite well with the figures given by Monsieur Holtzscherer for the centre of Greenland. Also the calculated velocity variation with depth agreed closely with a vertical seismic sounding from 100 metres depth at Maudheim. The temperature effect on velocity however appears to be small, but here variations in the firn structure

at limited depths may obscure the true temperature effect. In any case the unknown temperatures at great depths in the ice must limit the accuracy of all the measurements. For depth calculations in Dronning Maud Land a mean velocity of 3780 m/sec. was used, and the slower velocities in the surface layers have been allowed for by applying a correction varying from −24 metres near the coast to −40 metres on the plateau. The accuracy of the final result is probably around ±5 per cent. The reflection shooting technique was similar to that used by Monsieur Holtzscherer but seismometers were placed as close as practicable to the shot point (10–140 metres). Also shots were placed in boreholes from 2 to 12 metres deep to try to reduce the surface roll, and to eliminate the air wave.

In Dronning Maud Land seismic shooting measurements were carried out at 178 stations. Results were fully satisfactory at 98, and serve to define all the major features of the profile in Figure 7a. Probable or incomplete information available from a further 37 stations was drawn upon to add details to the profile. The line of the main profile is shown on the map (Fig. 8), together with lines of short additional profiles also measured. The surface heights used for the profile were measured by means of three aneroid barometers carried on the main seismic journey, and errors should not exceed 60 metres at any point. Although the ice was found to be of the same order of thickness as in Greenland, the types of ice cover investigated in Dronning Maud Lane differed considerably. They are therefore considered in some detail.

The profile.—For discussion this may be separated into four main regions, referring to distances as shown in Figure 7.

(1) *The Plateau inland from* 475 *kilometres.*—As there was considerable difficulty in obtaining echoes in this region, depth measurements are widely spaced and give little idea of the sub-glacial relief. That this is quite rugged is indicated by the surface profile, and by local bottom slopes of approximately one in six found at 516 and 615 kilometres. It is however thickly covered by ice up to 2400 metres deep, with the rock surface dropping to within 200 metres of sea level, and it appears that either the smoothing action of very thick ice sheets is not as great as was generally believed, or that this area is at present in a relatively early stage of erosion; a less likely alternative. One cause of the great ice depth is the damming action of the mountain ridge running from north-east to south-west, which includes Neumayer Veggen. A main drainage channel for the ice from the plateau appears to run northwards along the Greenwich meridian apparently causing the ice tongue which juts out from the general coastline at that longitude.

(2) *The inland ice from* 175 *to* 475 *kilometres.*—This could be described as a "Mountain Ice Sheet." [6] There was less difficulty in obtaining results over most of this region so stations are more closely spaced. The underlying relief shows a fjord type of landscape similar to east Greenland or eastern Norway, which is deeply buried by ice. Only in the mountain region from 310 to 400 kilometres do any appreciable number of mountain tops show above the ice surface. The surface profile is seen to reflect the major variations in the underlying relief on a reduced scale, but the underlying relief is too rough to apply to recent glaciological hypotheses such as that of Nye [7] who shows

that, under uniform conditions, surface slopes are inversely proportional to ice thickness. Some closely spaced stations were worked to examine the cause of the step-like rises in the ice surface. At 187 kilometres a step was apparently caused by a rock ridge submerged under 1100 metres of ice, while at 210 and 248 kilometres, only 500 to 600 metres covered the corresponding ridges. As other surface steps, not investigated due to limited time, were almost certainly due to submerged ridges, the underlying relief must be more rugged than is shown on the basis of actual soundings. This is particularly so on the rise to Neumayer Veggen from 420 to 474 kilometres, where few soundings, and the necessity of keeping clear of crevassed areas (probably thin ice cover), influenced the results.

The deep fjord type valleys at 300, 390 and 410 kilometres which drop from 500 to 700 metres below sea level were crossed approximately at right angles to the line of flow, so the profile gives cross sections. As the 390- and 410-kilometre valleys are 200 kilometres from the nearest ice shelf (floating ice), one can indeed see the broken nature of the country, which gives the impression of being actively eroded at present.

(3) *The Ice Hills* from 35 to 55 kilometres and 145 to 175 kilometres.*—These hills have a low rounded appearance which is typical of much of the eastern coast of the Weddel Sea, and of some of the southern half of its western coast. One naturally thinks of them as low rounded hills beneath a reasonably thick covering of ice. We found however that the rock surface was well below sea level in both these cases, and in a third case (Fig. 7) the rock surface was still 100 metres below sea level beneath the highest point of the ice hill. The criterion for the formation of an ice hill is apparently that there should be insufficient depth of water to float an ice shelf which otherwise would be expected to cover the area. The form of the ice hills is similar to that predicted by glaciological theory.[7] They are in fact miniature ice caps of widths up to 40 kilometres or so which may well repay a complete and detailed investigation of a type which would be impracticable on a major ice sheet.

(4) *The ice shelves.*—That these are floating through practically their entire extent is shown by the absence of tidal movement against the seaward edge, by analysis or barometric records at Maudheim, and by theodolite observations of the bending of the surface at the "ice shelf to ice hill" junction at one point. Associated with the bending were small characteristic surface cracks which opened and closed in accordance with tidal motion. Such cracks were found at most "ice shelf to inland ice" junctions inspected.

As the ice shelves are floating we have two possible reflecting horizons; the ice-water interface and the sea bottom which one anticipates will be the better reflector. In the preliminary and earlier work, all echoes found from shots on the ice shelf were shown to come from the sea bottom. Towards the end of our programme, when we had developed a more efficient hand boring technique and found the advantages of shooting at greater depths, a second echo appeared which must have come from the ice water interface. Plate 3 shows seismic records at three places on the ice shelves at which these echoes

* This name has been recommended by the Antarctic Glaciological Nomenclature sub-committee of the Royal Geographical Society.

were present, and echoes from the sea bed are also indicated. The most accurate measurement of the thickness of the ice shelf was that at Maudheim by the Swedish glaciologist Schytt. By extrapolating his depth-density curve, and considering the height of the surface and the density of the sea water, a thickness was obtained of 185 ± 5 metres. This depth was used to calibrate the echo at station 178 nearby; and from this, the depth to the ice-water interface was obtained at the four other stations.

Station No.	*Distance from Maudheim: kilometres*	*Thickness of ice shelf: metres*	*Thickness of water layer: metres*	*Depth of sea bed. Metres below sea level*
178	2	185	298	446
172	84·5	169	301	436
170	96	192	474	628
169	107	199	741	900
167	137	194	206	361

In view of the extremely flat surface of ice shelves, it is not surprising that the thickness variation in the above table does not exceed 30 metres. At 84·5 kilometres the station was located on the crest between two valleys about 8 metres deep; so it is not typical of a level expanse. The indication from the echoes from the sea bottom at this station and at 85·8 kilometres in a valley make it probable that there is a rise in the bottom surface of the ice shelf corresponding to the surface dip.

Apart from station 172, the other four thickness measurements lie within a range of 14 metres. Measurements at 137 kilometres are particularly surprising. There it appears that the ice has thinned out rapidly from a thickness of 460 metres at the edge of the ice hill to 195 metres on the ice shelf. This and other considerations suggest an idea which may be an over simplification that ice shelves tend to approach and maintain an equilibrium thickness of around 190 metres in this area. Once reached, this equilibrium thickness would be maintained by a spreading of the ice shelf so that

$$\frac{\text{Annual net accumulation}}{\text{Equilibrium thickness}} = \frac{\text{Increase in area}}{\text{Total area of ice shelf}}$$

Annual net accumulation in this case would include loss by melting or gain by freezing at the bottom surface of the ice shelf.

General

(1) *The Continental Shelf.*—It is apparent from this study that ice hills and ice shelves around Antarctica may cover much of, or in places all of, that area normally considered as the Continental Shelf. The absence of such a shelf, as reported by Herdman,[8] should not therefore be based entirely on shipboard information.

(2) "*Coastline.*"—In mapping an ice-covered region such as Antarctica, three possible ways of defining the coastline are present.

(*a*) The Ice Front, that is the seaward edge of the ice shelves. This has the disadvantage of varying from year to year with its advance or with the

calving of bergs. It is however easily definable at any time, so any ice front mapped thus should be dated. This is the coastline normally used.

(*b*) The seaward edge of the inland ice, which is also the inland edge of ice shelves, and furthest position to which sea water penetrates beneath the ice. It represents a more stable line than the ice front, but is more difficult to map. Where possible maps should include both lines.

(*c*) The normal coast line, what is the point at which the subglacial floor rises above sea level. It is quite impracticable to map this line in any detail, except with a vast expenditure on a programme of ice sounding. It does not represent the exact coastline should the region be deglaciated, as eustatic and isostatic changes would also come into action.

As regards existing mapping, the practicable possibilities seem reasonably clear. The three ways of defining such a coastline should however be remembered when discussing the extent of pleistocene glaciations, particularly in regions with a wide continental shelf.

DEPTH MEASUREMENTS OF ICE CAPS AND THE THEORY OF GLACIER FLOW

Comments on the above paper by J. W. Glen (Cavendish Laboratory, Cambridge)

One of the most interesting uses which can be made of the measurements of depth reported above is to check recent theories of glacier flow. Recent experiments on the deformation of ice [9] have shown that the rate at which ice deforms increases very rapidly as the shear stress rises above a certain value, and that this value varies quite markedly with temperature. Nye has pointed out [7, 10] that this fact enables one to relate the depth of an ice cap with its surface slope, and obtained excellent agreement with the main east–west profile found by Expéditions Polaires Françaises. The value of the shear stress used in this calculation was of the same magnitude as that needed to explain the shapes of temperate glaciers.[10] A stress of this order is also found for the small ice hills described by Robin and the North East Land ice cap Sørfonna.[11]

Using this value for the mean shear stress on the bed, Nye was able to predict the depth of the bed under the whole of the Greenland ice cap. He deduced that the southern dome overlies mountains some 1000 metres high, but that the northern dome covers a depression which may be more than 4000 metres below sea level. Even if the stress is halved, the rock would be 1000 metres below sea level at its lowest point.

The additional evidence now provided by Holtzscherer's paper confirms the existence of the southern mountains with a height of about 1000 metres and the northern east–west profile (79° N.) is also in agreement with Nye's predictions. The one point where there is an apparent disagreement is at the northern end of the north–south profile, where Nye's map would indicate rock 1000 metres below sea level and Holtzscherer found no such depression. It is however just in this region that the surface slope is hardest to deduce from the Danish survey map used by Nye, and it is quite possible that this gives rise to the discrepancy. Further north it would not be possible to account for bedrock at sea level in this way, unless the height of the northern dome were wrong by many thousands of metres, and it is much to be hoped that seismic depths will be determined in this area.

In comparing the results of predictions on the Nye theory with depths

measured seismically, it is as well to remember the assumptions implicit in the theory, all of which must be satisfied if the predictions are to be correct. Apart from the question of the accuracy of the surface contours used to deduce the surface slope, two major assumptions are made.

(1) It is assumed that the ice is flowing at all points, this is only true if the accumulation at the surface is more than sufficient to balance any bottom melting. If this were not true, then the centre of the ice cap would be stagnant and the depth predicted by Nye would be too large. Despite the difficulty of measuring nett accumulation in such a region, it seems fairly certain that this assumption is justified throughout Greenland.

(2) It is assumed that the shear stress causing flow at the bed is of the same magnitude at all points. There are several reasons why this might not be true. In order to eliminate the predicted depression in northern Greenland, the shear stress in that region would have to be lower. This could arise in the following ways: (*a*) the strain rate might be much lower. Using the law found in the laboratory,[9] the mean flow rate would have to be less than a tenth of what it is along the main east–west profile. This in turn implies a much lower accumulation. (*b*) The ice might have a different structure, *e.g.* a greater degree of preferred orientation. A large difference due to this seems unlikely. (*c*) The temperature of the bed might be higher. This seems improbable since the stress found in the south is roughly that for the melting point. (*d*) The pressure of the overlying ice might reduce the shear stress needed to produce a given strain rate. This is unlikely, since in most solids a pressure gives the opposite effect, but it cannot be completely ruled out. If this is the case, it is surprising that the southern profile gives a shear stress in good agreement with that found from the small ice hills in Antarctica. (*e*) The pressure might melt some of the ice and thereby produce a lubricating effect. This depends on many factors, in particular the supply of latent heat. Again, it should also enter in the figure used in the main east–west profile.

In spite of this rather forbidding list of pitfalls, the Nye theory works surprisingly well in all the cases where it can be checked. This agreement gives further evidence that the various assumptions are justified, and in particular, that the temperature at the bed must be within a few degrees of the melting point.

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HYDROGRAPHIC ANALYSIS OF THE GOODWIN SANDS AND THE BRAKE BANK

R. L. CLOET

THERE MUST be few mariners who are ignorant of the existence and the dangers of the Goodwin Sands. Together with the Brake Bank, the Sands form a distinct submarine morphological unit, much less complex than the banks in

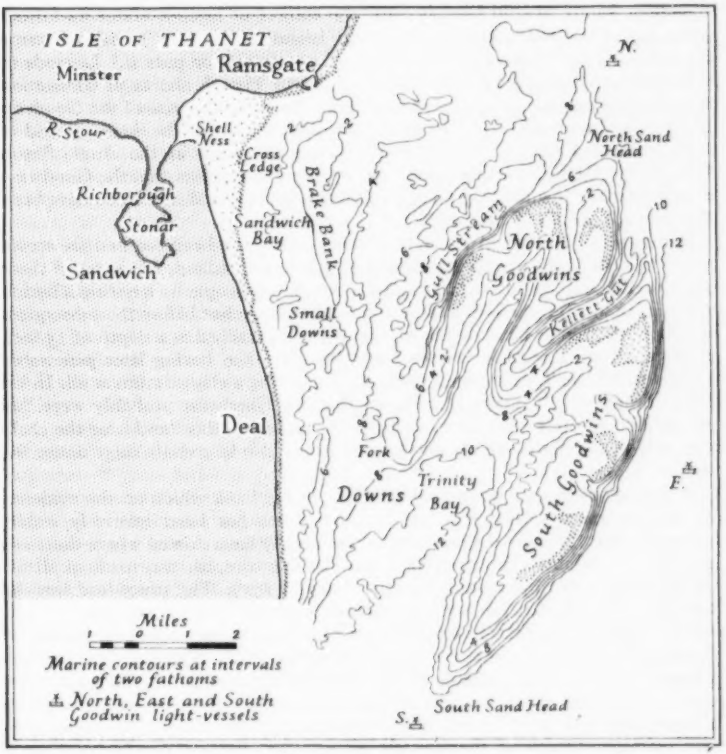


Figure 1

the Thames Estuary, or the series of sandbanks off the Franco-Belgian shoreline.[1] Because of this relative simplicity we are in a position to analyse the movements in which the two banks are subject (see Fig. 1).

[1] Admiralty charts nos. 2182a and 1828 (London).

The Goodwin Sands undergo a slow rotatory movement in an anti-clockwise direction, whereas the Brake Bank has an overall coastward component. From the navigator's point of view the importance of the rotation lies in the westward movement of the western North Goodwins, and the eastward movement of the South Sand Head. The former tends to narrow down the Gull Stream while the latter infringes on the outer shipping lane round the sandbank.

Because of its position on one of the busiest shipping routes of the world, the Goodwin Sands receive much public attention, and a number of confused statements have from time to time been made about the nature and origin of the bank. It is the object of this paper to discuss the stability of the Goodwin Sands in particular, and to account for the pattern of sediment circulation as shown by surveys made over the last hundred and fifty years.

It is perhaps only natural that a large and dangerous sandbank, like the Goodwin Sands, should have become the subject of legends about its former existence as a fertile island (the ancient island of "Lomea") which became drowned by the "convulsions of Nature," as one author puts it.[1] Legends of this kind are found on the Flemish and North French shores in connection with the submerged sand ridges to be found there. In the case of the Goodwin Sands, the disappearance of the island, marking the site of the Sands, is said to have coincided with a great storm in 1099, recorded in the Anglo-Saxon Chronicle.[2] Gattie, quoting some "early writers", suggests that the Goodwins are the "Infera Insula" they mention, but this latter island could also have been Stonar bank, north of Sandwich.

A number of borings in which clay was said to have been reached are sometimes taken as evidence of the existence of a former island, but none of these reports can be traced. Lyell has misled a number of people by ignoring a boring made in 1849, after the publication of the first edition but before the subsequent ones.[3] He stated in his first edition that clay was reached at a depth of 15 feet, without giving a position on the bank, but the 1849 boring later penetrated 78 feet to the chalk substratum without penetrating a clay stratum at all. In his later editions Lyell retained unaltered that the Goodwins probably were "an island like Sheppey composed of clay" only adding to this "and later the chalk was reached." Hence the theory that there may also be a chalk ridge under the bank.[3]

I have attempted to determine that part of the bank which on the evidence of surveys made during the last hundred years has been relatively stable, assuming that the clay-covered "island" could only have existed where there is a measure of stability. In compiling a chart of this core, use was made of all the Hydrographic surveys made between 1844 and 1947. The procedure was the following: The survey fair sheets, which are on scales of 1/25,000 and 1/36,500, were contoured at 1-fathom intervals. One particular contour was then collected from each of the different surveys onto a separate sheet. This was done for each contour over the whole depth range. On each collector sheet there remained now a blank area inside the belts of fathomlines. Now this area, on the evidence of the surveys, has not at any time between 1844 and 1947 been deeper than the particular depth of the contour in question. Since the area has proved stable, or at least fully compensated between the survey dates, the chart which has been compiled from the new limiting contours is a "stability chart." Clearly the chart is only a record of a relatively short period and its reliability depends

[1] G. B. Gattie, 'Memorials of the Goodwin Sands' (London, 1904).
[2] B. Thorpe ed. 'The Anglo-Saxon Chronicle,' ii, 1861, p. 203.
[3] Sir C. Lyell, 'Principles of Geology' (1st edition) (London, 1830), vol. 1 p. 276.

on the frequency with which surveys were made during that period, and the rate at which the bank moves. Earlier surveys were not included because of the difficulty of transferring them to a modern chart. However, we must consider the trends of movement which they show to have existed before 1844.

The stability chart (see Fig. 2) has been drawn at 2-fathom intervals to avoid its becoming illegible, but in the vicinity of the Brake Bank, the 3- and 5-fathom stability contours have been added to give a better delineation of the topography. On the Goodwin Sands, it will be noticed that little remains which is shoaler than 2 fathoms. Of the four 2-fathom patches which remain, the two southernmost would disappear once the earlier surveys were included. There remain the two "islands" on either side of the Kellett Gut. With sea level as it is at present, the case for an inhabitable island is poor, but the Dunkirkian transgression which occurred about A.D. 400 raised sea-level by 4 to 6 metres in Flanders, or by about 3 fathoms.[1] This means that the hypothetical island could have been above chart datum in pre-Dunkirkian times, but not at any later date. However, this lower sea-level would still make it liable to flooding at every high tide to a depth of at least 10 feet. In other words the existence of a bank uncovering at low water, as at present, may have applied also in Roman days, which bears out Holmes' theory that "an obstacle existed here in Cæsar's time." [2] The evidence suggests that the flooding in the eleventh century was probably only of a local nature. Since the Goodwin Sands are well off shore and have deep water all around, such flooding would not in any case have had anything like the same effect as one gets in shoaler water. It is more likely that if it had been possible for an island to exist here it would have been destroyed by A.D. 400.

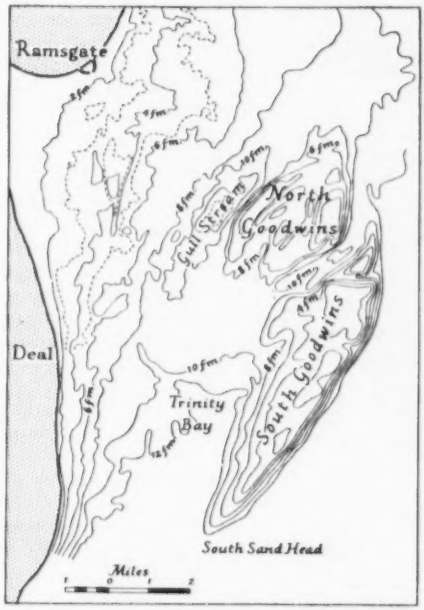


Figure 2

Examining the problem morphologically, we conclude that the feature which possibly existed is likely to have been similar to the present-day Goodwin Sands. Any island which could have been artificially reclaimed by relatively primitive methods would have been in a very precarious position at best.

The composition of the Goodwin Sands.—Our most detailed knowledge of the

[1] R. Blanchard, 'La Flandre' (Paris, 1906), pp. 135–47.

[2] T. R. Holmes, 'Ancient Britain and the invasion of Julius Cæsar' (London, 1907), p. 528.

composition of the bank derives from the 1849 boring made under the supervision of Sir J. H. Pelly of Trinity House [1] (Fig. 3). It reached the chalk substratum at a depth of 78 feet below sea-level or 82 feet below the surface at the time. There is no evidence of clay strata in the column at all. Clay was reported in other borings on the Sands made about 1790 and 1817, but at the depths at which it purported to have been found the bank is so unstable that any idea of an ancient land level is untenable. It is probable that nothing more than "clay nodules," or rounded lumps of clay, were encountered, as were found in 1849, or possibly a clayey sand. Reference to Figure 3, which shows the 6-fathom line for 1844 and 1947, gives some idea of the amount of movement to which the Sands are subjected. When investigating the literature, it becomes evident that the reports by various authors of clay having been found nearly all derive from Gattie's book on the Goodwin Sands. Reports of the borings of 1790 and 1817 mentioned by Lyell and already referred to, in which clay was stated to have been found at 7 and 15 feet respectively, are extremely vague and no position is available for them. In any case they have little significance because the bank has been thoroughly disturbed at these depths.

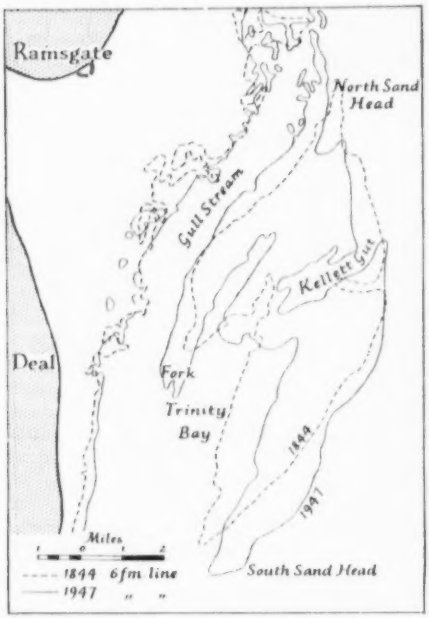


Figure 3

The chalk substratum.—By itself, Pelly's boring gives very little information about the chalk topography under the bank. In order to gain a better impression of this topography, a chart has been compiled on a principle not dissimilar to the one used for the stability chart.

Whenever an Admiralty survey is made, the "quality of bottom" is determined at a number of points. Around the Goodwin Sands, the rock floor is covered by only a thin layer of superficial deposits and the chalk itself is exposed in various places at different times. The soundings where the quality of bottom was determined as chalk have been collected from all the surveys and replotted on a collector sheet; a closer distribution than normally occurring on any one of the surveys then becomes available for examination. Figure 4 shows the chalk soundings so obtained, as well as chalk surface contours based on these soundings. Superimposed on this, to facilitate comparison, is inserted the 10-fathom line from the stability chart.

The traditional method of sampling, to determine the quality of bottom,

[1] G. B. Gattie, 'Memorials of the Goodwin Sands' (London, 1904).

still employed in some cases, is the use of the lead line. The hollow in the base of the lead is filled with tallow; sand, or small pieces of gravel, either stick in it or leave an imprint. Rock often makes no recognizable impression on the tallow, but it is identified by the marks left on the lead. The method, although crude, does yield surprisingly reasonable results in practice.[1] It may be thought that chalk boulders might easily have been mistaken for the solid bottom, but in this case we can refer to the stability chart which provides a useful check. By superimposing the stability chart on the chalk chart, we can ascertain whether a greater depth was recorded at any time and on any one of the surveys where a particular chalk sounding was recorded. Those chalk soundings which lie above the stability surface have been rejected since they cannot have been rock bottom, at least if their position was accurately determined.

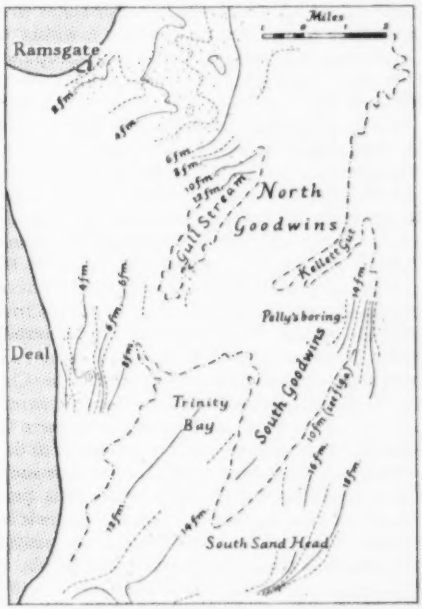


Figure 4

We naturally expect a higher density of chalk soundings to occur where the unconsolidated capping is thinnest, or most frequently disturbed. Such an area is found to exist east of the Isle of Thanet (Fig. 4), where a conspicuous feature can be discerned from the trend of the contours. It is a ridge which marks the continuation of the Minster anticline, forming the southern slope of the Isle of Thanet on the mainland. The ridge curves south-eastward to be finally lost just north of the Gull Stream, where the sand cover is disturbed less frequently. However the trend of the contours suggests that the ridge may continue under the Goodwins. There are few chalk soundings in the Gull Stream, but the rock bottom is found at 12–13 fathoms near the north end, while east of the southern entrance are two 9-fathom soundings, and south of it a 10-fathom sounding. They indicate that the Richborough synclinal fold persists as far east as this. Furthermore, if we take the evidence of the stability in conjunction with the chalk chart, we discover the possible existence of a channel cut into the chalk, at least at the southern end of the Gull Stream. It is conceivable that this channel was cut at the time of a lower sea level, the period preceding the Flandrian transgression. If so it may have been an over-spill channel established about the time the Creux de Lobourg was breaking through the Straits of Dover.[2] The Creux de Lobourg runs along the eastern slope of the

[1] W. B. R. King, "The Geology of the eastern part of the English Channel," *Quart. J. geol. Soc. Lond.* 104 (1948) 327–36.

[2] A. Briquet, 'Le littoral du nord de la France' (Paris, 1930).

Goodwin Sands, as can be seen from the closely spaced chalk contours east of Pelly's boring. It is thought to have been a river channel which cut back through the isthmus joining Britain to the Continent. Alternatively the ponded water, in front of the ice in the North Sea basin, may have over-spilled through a number of channels of which the Gull Stream was one, and eventually have established the Creux de Lobourg as the only permanent drainage channel.[1]

The movement of the Goodwin Sands.—The more obvious trends of the movements of the Sands have been known for some time. Admiral Beaufort, a far-sighted hydrographer, commenting on General Redman's plan for building fortifications on the Sands, in 1848 states in his minutes to the Lords Commissioners of the Admiralty: ". . . within these few years, since they (the Goodwins) have been surveyed with scrupulous accuracy, it appears that they have all had an annual movement to the westward, constantly tending to narrow the Gull Stream, although the Brake Bank is also approaching the shore." [2]

Before attempting to unravel the interrelated evolution of the Goodwins and the Brake Bank, together with its effect on the development of the shoreline, I will now examine the Goodwin Sands separately. It is by far the major bank and an appreciation of its movement will help us greatly in understanding the larger circulation. The most remarkable feature of the Goodwin Sands, which almost completely severs the South Goodwins from the North, is the Kellett Gut. It was much discussed when H.M.S. *Kellett* demonstrated its existence in a survey made in 1926. The Kellett Gut cuts right across the widest part of the Sands, yet there have been periods during which this channel ceased to exist altogether. The survey of 1865 showed no sign of it, nor did it exist between that date and 1896, the date of the last survey before 1926 which covers the area of the Kellett Gut. The Channel does appear on the 1844 survey of Captain Bullock (Fig. 3) as well as on the 1795 survey. Though it still appears on the 1936 and 1947 surveys, there are unmistakable signs that it has been shoaling and presumably continues to do so.

The Gut is remarkable for its size, but such a channel as this, cutting right across a sandbank seemingly where it is firmest, is not an unusual feature. There are some equally well-known channels crossing the Banks of the Thames Estuary. Robinson [3] recently gave an analysis of the Edinburgh Channels, twin channels cutting across the Long Sands. Channels of this nature are called "swatches" or "swatchways," words deriving from the Saxon "swaeth," meaning furrow. Such swatches are not necessarily as deep as the Kellett Gut, which attains 13 fathoms, but they appear to cut through the unconsolidated sediment to the firmer substratum. In the case of the Kellett Gut, this is the chalk, and in the case of the Edinburgh Channels probably the London clay, or at any rate a well compacted clay.

On old pilot charts, the Goodwin Sands are often shown divided into two parts in the approximate latitude of the present Kellett Gut. Sometimes "swatch" is written against the eastern entrance to the channel, indicating it to be the principal and probably the deepest of the several possible swatches. Lucas Waghenaer, the Dutch navigator, who gave his name to the "waggoners," as charts used to be called, shows the Sands entire, without swatchway, in 1584, but another Dutch cartographer, Pieter Goos, represents the bank in two sections in 1666. Labelye, in 1736, and Ross, in 1779, also chart the swatch. The

[1] P. Tesch, "Over de onderzoekingen in de Hoofden en langs de Nederlandsche Kust" *Tijdschr. Kon. Ned. Aardr. Gen.* 1937.

[2] Hydrographic Department of the Admiralty, Archives.

[3] A. H. W. Robinson, "The changing navigation routes of the Thames Estuary," *J. Inst. Navig.* 4 (1951) 357–70.

latter however shows a 3½ fathom sounding in the swatch, indicating that the channel was not then fully formed. In 1795, the swatch was well established, and down to the chalk at 13 fathoms as shown by a chalk sounding on the survey. The swatch continued to exist until about 1850 (it was there when the boring was made in September 1849 close south of it), but there was no trace left when a survey was made in 1865. As stated before, the Kellett Gut was discovered in 1926 in about the same position as where the swatch had been, but it would appear from information provided by Mr. Kirkaldie, former coxswain of the Ramsgate lifeboat, that the Channel actually came into being about 1910, and was used by some vessels during the First World War.

On the landward side of the North Goodwins an interesting evolutionary cycle has been observed along that limb of which the Fork is the southern extremity. On the surveys of the last thirty years, it has been possible to see a slight inflexion in the fathomlines, near the North Sand Head, grow laterally deeper into the bank, while the entire feature was travelling down the Gull Stream. That inflexion, which may be called a lateral wave, gradually took on the appearance of a recurved spit (Fig. 1). The neck of this spit grew more tenuous, until a small shoal, the original recurved end of the Fork, was thrown off, as can be seen on the 1945 survey. Unfortunately, the 1947 survey did not cover the area where the remains of this shoal should still have been. It has doubtless disappeared by now, and was probably quite small even in 1947. A new cycle may already have started near the North Sand Head.

There is sufficient evidence from the surveys of the past century to suggest strongly that we are dealing with a more or less continuous series of lateral waves travelling down the Gull Stream. These waves do not occur either on the Brake Bank, or on the eastern side of the Goodwins, but the more common type of wave, the so-called giant ripple or sandwave, has been found on the Brake Bank and described on the Goodwin Sands.[1]

When considering the outline of the Goodwins, which I have for convenience taken as the outer 6-fathom line, one is struck by its resemblance to a symmetrical aerofoil, except for the gap caused by Trinity Bay, and the smaller indentation of the Kellett Gut (Fig. 5).

By fitting aerofoils to each of the surveys from 1795 to 1947 it becomes possible to analyse the general movements of the sandbank in relation to (1) length of the major and minor axes; (2) angle at the nose or rounded end of the bank; (3) orientation of the shape in the flow, or in this case the angle of the major axis with the meridian. The major and minor axes are the dimensions of length and width, while the angle at the nose gives an indication of how far along the length the greatest width occurs.

When we consider the length of the bank from 1795 onwards, we see that the main bank is now shorter than it was in 1795, although it has increased in length since 1844 at an average rate of 0·6 cables per decade or about 4000 feet per century. However, the minor axis has shown an almost steady but slight increase since 1795. The general trend resulting from this is seen to be an expansion of the bank. It should be noted that this trend was temporarily reversed between 1887 and 1916 (see Fig. 5), the period during which the Kellett Gut ceased temporarily to exist.

The angle at the nose has become sharper since 1795, with a reversal of this trend about the same time as in the case of the expansion of the shape. The sharpness of this angle is also closely related to the size of the minor axis, as if

[1] R. L. Cloet, "Sandwaves in the Southern North Sea and the Persian Gulf," Lecture at the Challenger Society, January 1954 (to be published, *J. Inst. Nav.* 7, 3 (1954)).

the bank expands as a direct result of sediment being redistributed from the North Goodwins southwards. We will return to this point when the overall sediment circulation is discussed.

The orientation of the Sands is here taken to mean the angle of the major axis with respect to the meridian, which is also the angle of the axis of symmetry with the meridian. The trend has been a rotation towards a north–south alignment, which has been slowing down steadily until at present it seems to be almost stationary, though it would be unwise to attempt any predictions. There are again signs of a temporary reversal of this trend between 1887 and

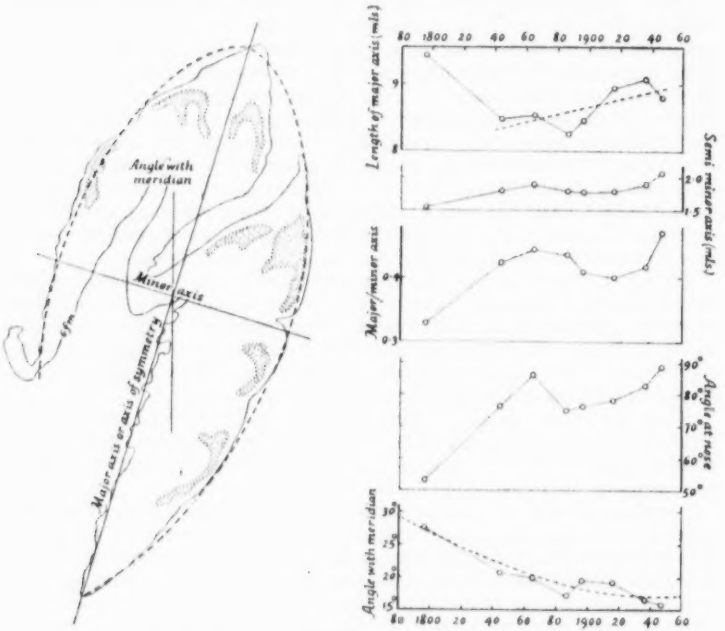


Figure 5

1916. The use of the aerofoil for this trend analysis is possible because the position of the Goodwins in a converging flow towards the Strait of Dover from the North Sea seems to have produced a feature of which the extremities, The Fork and South Sand Head, are also converging, but we must not lose sight of the fact that a considerable portion of this ideal shape is missing in Trinity Bay.

The Brake Bank.—Extending southward from the mainland of Thanet at Ramsgate, lies the Brake Bank. As was pointed out by Admiral Beaufort in 1848, the Brake was (and still is) moving towards the coast. On closer examination however we discover that this movement is not a simple coastwise motion, but that the Bank is bending into Sandwich Bay, tending more and more to take the curvature of the Bay (Fig. 6). The middle portion, which corresponds in latitude to the position of the former Cross Ledge, has moved relatively farther

west than the southern extremity. The Cross Ledge is now covered by the main bank, which has passed sufficiently far beyond it for the leading line into Ramsgate Harbour to have moved farther west.

A survey of Cross Ledge, made in 1950 as a result of yet another report of westward movement, revealed the existence of an interesting set of sandwaves.[1] An analysis of the E/S, or echo-sounding, traces showed that these were not moving westward. The crestlines of the waves were west-north-west to east-south-east, approximately transverse to the direction of movement. Thus by implication we have a local sediment transportation across the line of movement of the Brake Bank as a whole, but interestingly enough in the same direction as the coastal drift from Deal towards Shell Ness at the entrance of the Stour.[2]

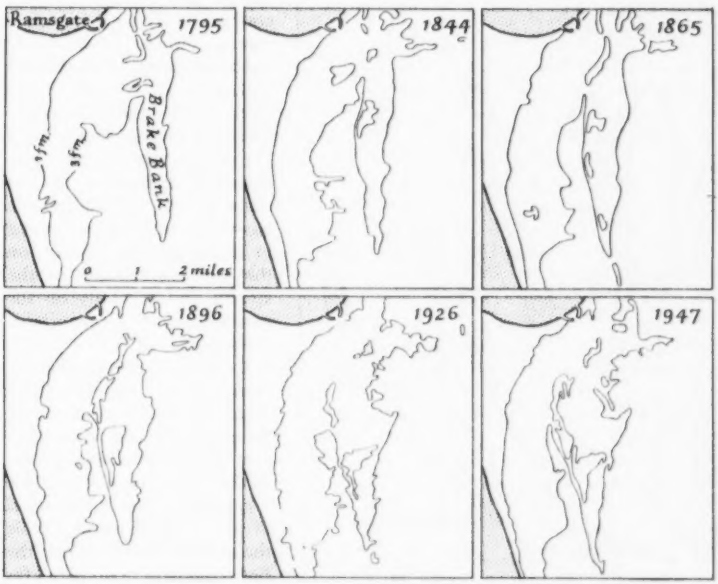


Figure 6

The evolution and shape of the Goodwin-Brake system.—An interesting explanation of the layout of this sandbank system can be derived from a theory advanced by Van Veen, Chief Engineer of the Dutch Waterstaat.[3] He states that ebb and flood establish individual channels and tend to throw up obstacles against each other in the shape of blunted wedges which could be termed parabolic wedges.

[1] R. L. Cloet, "Sandwaves in the southern North Sea and the Persian Gulf," Lecture at the Challenger Society, January 1954 (to be published, *J. Inst. Nav.* 7, 3 (1954).

[2] A. H. W. Robinson and R. L. Cloet, "Coastal evolution of Sandwich Bay," *Proc. Geol. Ass., Lond.*, 64, 2 (1953) 69–82.

[3] J. Van Veen, 'Onderzoekingen in de Hoofden in verband met de gesteldheid der Nederlandsche Kust' ('sGravenhage, 1936).

For example, in a field of transportable material a maximum amount of sediment is removed along the line of maximum velocity, the amount of transported material decreasing rapidly on either side. Consequently there is more sediment available for deposition along this line when the tide turns, resulting in a sediment wedge with maximum height at the apex. The opposing tidal stream is thereby deflected but similar features are produced on one or both sides of the first wedge and in the opposite direction. Once this system is formed, the residual water movement inside the elongated wedges increases in size, there being alternately ebb and flood residuals alongside each other. On the whole, the existence of residual water movement in one or other direction is accompanied by a net sediment transportation. In this way sediment carried with the ebb will tend to collect in the ebb wedge and conversely sediment carried on the flood in the opposing flood wedges. It follows from this that the shape of the wedges and the amount of sediment contained in them depends firstly on the carrying capacity of the stream and secondly on the availability of transportable sediment.

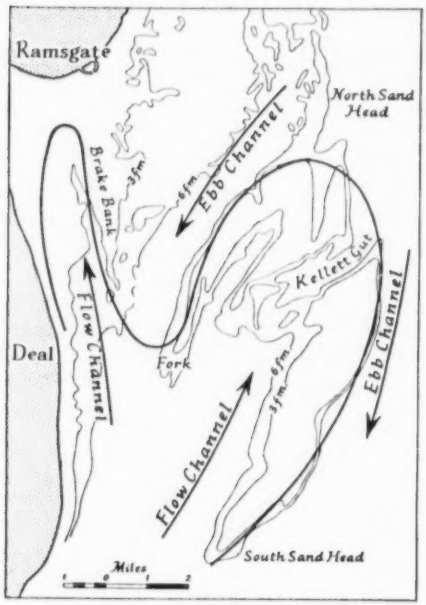


Figure 7

In the case of the Goodwin Brake system we have two flood channels, one into Trinity Bay and the other into the Small Downs, west of the Brake Bank. These are separated by the ebb channel of the Gull Stream, while the residual current along the East Goodwin light-vessel (as recorded in 1889) makes the outside of the Goodwins also behave as an ebb channel (Fig. 7). Can this system of channels, in the light of our interpretation of Van Veen's theory, provide a satisfactory explanation of this sediment movement?

I have shown that the sediment of the Cross Ledge is travelling northward. A recent Notice to Mariners earlier this year reported slight shoaling just north of Cross Ledge and may be taken as supporting evidence of this.[1] It is also in accord with sediment movement in a flood channel. The Goodwin Sands outer contour is expanding. This is in agreement with what can be expected to happen in a flood channel which carries more than the adjacent ebb channels. Where this is the case, the return movement of the ebb channel cannot entirely dispose of all the sediment which has overspilled the flood parabola. The Gull Stream ebb channel is incomplete at the head of that channel because ebb,

[1] Admiralty Notice to Mariners no. 2817/1953 (London).

coming across the almost barren chalk shelf east of the Isle of Thanet, does little more than move sediment by longitudinal drag on the Goodwin and Brake Banks. It is this drag which is responsible for the lateral wave travelling down the side of the North Goodwins to the Fork. The overspilling of the Trinity Bay flood channel is greater at South Sand Head, where the ebb residual flow, along the outside of the bank, has become less marked. The resulting movement of the whole of the sandbank due to the unequal outward movement of the Fork and South Sand Head is, as we have seen, a counter-clockwise rotation. This in its turn is responsible for the Brake being pushed westward by the Gull Stream channel trying to maintain the debit of water through it. Although the Small Downs flood channel west of the Brake is able to move some sediment northwards, it is weaker than the Trinity Bay flood channel.

So far the North Sand Head has not been mentioned. It is a relatively small shoal mostly detached from the Goodwins proper and elongated in the prolongation of that bank, though somewhat to the west of the extended axis of symmetry. The ebb stream coming from the northward divides on reaching the Sands into the Gull Stream and east of the Goodwins. This leaves a wedge of almost no velocity in the upstream prolongation, where sediment deposited by the opposing flood stream is unlikely to be much disturbed. It is in any case also an area where secondary flow in the ebb stream would tend to deposit sediment, since it is a known fact that sediment is moved from the lines of greatest velocity to the area of least velocity.[1] In this way the North Sand Head could be brought into being and maintained, although its size probably depends on the width of the Goodwins, and of course on the amount of sediment brought on. This formation of a shoal heading into a residual flow and possibly extending in that direction as the size of the main sandbank increases, may also well be the reason why the north pointing spit east of the Kellett Gut, on the South Goodwins, has been extending some distance northward between 1936 and 1947.

The Kellett Gut is a major feature of the Goodwins. It is cut down to the chalk substratum and appears to be a further formation in the ebb and flood channel system. Indeed it has penetrated with its sediment wedge some way into Trinity Bay, while the flood channel has penetrated deeper into the North Goodwins between it and the Fork.

It has been seen that the Goodwin Sands expanded fairly steadily from 1795 to 1865 and from 1916 to 1947. Similarly, the rotation of the major axis showed a reversal of the trend over the same period. On the whole the ebb movement of sediment is insufficient to remove the material which the f ɔwise expansion of the flood channel in Trinity Bay has brought on. The expansion of the North Goodwins is successfully counteracted, as is evidenced by the increasing angle at the nose of the aerofoil. The ebb probably carries little sediment in suspension until it reaches the Sands. It does therefore not contain any worthwhile amount of sediment along its maximum flow streamline but this is brought into suspension by longitudinal drag along the bank. The ebb can then successfully counteract flood only where it is not saturated with sediment, *i.e* on that part of the aerofoil which is in front of the greatest width.

Flood widens the bank, thereby increasing the obstacle in the path of the ebb, and the ebb flow streamlines converge even more as a result. Also it is conceivable that the ebb sediment transportation is able to remove the fine fraction from the grain-size distribution of the sand in such a way that the homogeneity of the sediment is disturbed at a critical point along the outline

[1] L. Prandtl, 'The essentials of fluid dynamics' (London, 1952).

of the bank. The combination of a steep velocity gradient alongside, due to the closing up of streamlines and the removal of the cohesive fraction from the sediment, may produce a breaking point which leads to the formation of a channel like the Kellett Gut. This explanation is of course tentative, but it could probably be cleared up if a set of samples could be obtained from the bank and the grain-size distribution in them analysed.

This theory does not, perhaps, provide a clue to the formation of swatchways in general, as for instance the navigationally important Edinburgh Channels, lying farther north, in the Thames Estuary. I am unable to offer an adequate alternative to Robinson's suggestions that the later arriving English Channel flood stream has cut across the Long Sand, but in this case one would expect that the broad rise joining the Tongue Sand and Kentish Knock which would lie in its path should also have been cut into. I believe that we should think along the lines that these Thames Estuary banks contain the greater part of the transportable sediment and that here also there exists a cell circulation of sediment on each bank. I have given a description of the possible development of this type of circulation in another paper.[1] It seems possible that in the case, both of the Edinburgh Channels and of the Kellett Gut such cells become over-extended by an excess of sediment transportation in one direction. This cell may then become unstable and a swatchway is cut at the critical place. It is worth noting that there are hardly ever two deep swatches close together across one sandbank. The Edinburgh Channels have become separated by the growth of a shoal (Shingles Patch) in the original channel.

To summarize, I have advanced some arguments suggesting that the Goodwin Sands consist of an accumulation of sediment resting on a fairly even chalk surface. The existence of a former island is doubtful, and the only evidence of it is legendary and of questionable value. However, the Sands, though subject to an appreciable amount of movement, have probably existed in their present position for a considerable time. The reason why the Goodwins do not move either into the Straits of Dover or farther into the North Sea is thought to be the interplay of an ebb and flood channel system of transportation. Because either one or the other stream is locally stronger on different parts of the same sandbank the addition of sediment seems to produce a *widening* of the feature where the opposing stream is least able to counteract this tendency. This continues until a new balance is temporarily achieved. Superimposed on it is the differential effect of two flood channels on the enclosed ebb channel of the Gull Stream. The ebb is weaker as a sediment carrier than the flood in Trinity Bay, while it does more than keep in check the expansion of the Small Downs flood channel. It has been suggested that the formation of the Kellett Gut is a response to the widening of the Goodwins. The occurrence of a lateral wave on the Gull Stream side may be parallel development where the inequality of capacity between ebb and flood channels is not so marked, the stress does not here build up to breaking point.

It may be that we can go still further and surmise that eventually the whole arm of the Fork may be severed from the Goodwins while a new North Goodwin develops from that part which is north to the Kellett Gut and the Brake Bank merges with the shore. This brings us to the larger conception of sediment circulation on an open shore, which may be possibly an almost closed cell circulation within each limb between ebb and flood channels, superimposed on

[1] R. L. Cloet, "Sandwaves in the Southern North Sea and the Persian Gulf." Lecture at the Challenger Society, January 1954 (to be published, *J. Inst. Nav.* 7, 3 (1954)).

a slow drift of the sandbanks toward the shore as their sediment content is slowly increased.

This latter drift is not likely to be continuous but probably consists of a growth to unstable proportions followed by a severing from the parent bank. The formation of the Kellett Gut may consequently either be an attempt to redress the balance between ebb and flood, or be the beginning of a more drastic change culminating in the origin of a new Brake Bank.

Acknowledgements.—The author desires to express his thanks to Dr. J. N. Carruthers for placing at his disposal a number of important references, in particular those of Dutch origin; and to several friends for their useful suggestions in preparing this paper. The figures have been compiled from documents in the Hydrographic Department of the Admiralty, and the author is grateful to the Hydrographer of the Navy and the Controller of H.M. Stationery Office for permission to reproduce them. The responsibility for any statements or opinions rests solely with the author.

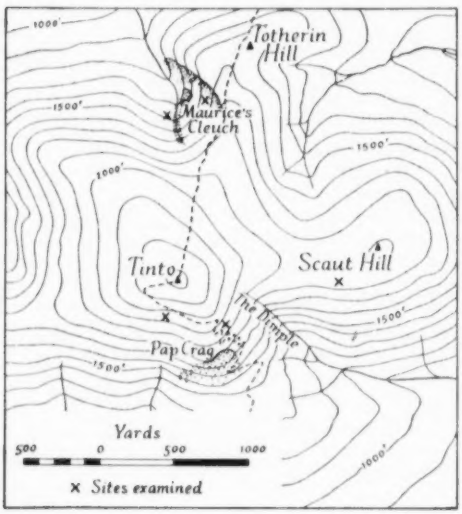
STONE STRIPES AND OTHER SURFACE FEATURES OF TINTO HILL

R. MILLER, R. COMMON AND R. W. GALLOWAY

TINTO HILL, in upper Lanarkshire (NS 9534), is a laccolith of felsite set in basal Old Red Sandstone which is disposed broadly in a syncline parallel and adjacent to the Southern Upland boundary fault. The superior resistance to erosion of the felsite makes of Tinto a bold asymmetrical triangular pyramid rising to 2335 feet as a circumdenudation feature dominating surrounding country of some 750 feet elevation. The longest side of this pyramid is about four miles east–west and the shortest two miles north-west–south-east. Above 1600 feet the gradient decreases so markedly as virtually to amount to a truncating of the pyramid, creating three subsidiary summits at *c.* 1600 feet, 1700 feet and 1900 feet, one on each edge of the pyramid and each about one mile from the main summit, which culminates in an almost level platform of an acre or two in extent bearing on it a cairn some 10 feet high and 30 feet in diameter.

Two normal submature valleys drain to the north-east and north-west respectively while almost due north is the deep incision of Maurice's Cleugh and due south a similar but lesser feature, the Dimple. Linton (1933) has shown that both of these while resembling corries are in fact not such.

Exposures of bed-rock are very few and small except where a porphyrite dyke forms the excrescence of Pap Craig. Elsewhere the hillside is remarkably smooth and for the most part clad in a mantle of dry heather-grass moorland. In places however, and no doubt owing to excessive burning and grazing, the vegetation cover is absent and the underlying rock-waste is exposed. It is in some of this uncovered rock-waste that the patterned ground (Washburn, 1950) occurs. It is to be found in three areas only; the largest, totalling about 15 acres, is in Maurice's Cleugh; there are some 5 acres in the Dimple and on the south side of the summit several disconnected patches probably total rather more than 5 acres. The lower limit of the stripes is about 1900 feet on the south side and 1300 feet on the north.



Only on Pap Craig, in the bottom of Maurice's Cleugh and to the east of the Dimple, in each case on slopes exceeding

27 degrees in steepness, can debris resembling normal scree be found. The resemblance lies in the loose packing and often unstable equilibrium of the stones, betokening fairly rapid progress down the slope. Unlike a normal scree however there is, except on the Pap, no evident exposure of bed-rock at the top of the talus and no terminal accumulation, at the bottom where instead debris is scattered widely over the grass and heather, suggesting that the scree is advancing rapidly. Elsewhere, the rock fragments are more or less compacted and over at least half the area arranged in the pattern known as stone stripes (Hollingworth 1934 and Hay 1936, 1937, 1943). In the Dimple a very small area shows a form of inverted festoon arrangement

The stone stripes vary somewhat from site to site but they all have in common the following characteristics: the material involved ranges from a fine black peaty substance, probably representing debris from eroded peat, through sand and small stones to angular fragments up to 6 inches in maximum dimension but with the majority only a few inches long. All have a tendency, due no doubt to frost shattering and the type of jointing in the felsite, to have an elongated and flattened form. Below 4–6 inches from the surface, the material is quite mixed. In the upper 4–6 inches, however, the striping is formed by a segregation of the coarse from the fine material. The fine material is disposed in ridge and furrow of a width varying from 8 to 14 inches and with a furrow depth of 3–6 inches; the furrow, however, is filled with the largest fragments in the formation, usually to a depth which gives the whole structure a fairly level upper surface (Plates 1, 2). There is however a tendency, where the fine material contains a high proportion of peaty sand, for this part of the stripe to be upstanding and even in places for a narrow ridge of the finest material to protrude one or two inches above the general level of the stripe of finer material (Plate 3). Stones in both the coarse and fine stripes generally lie flat with their long axes across the contours. Fragments on the surface are more sharply angular than those at depth, suggesting chemical attack in the latter situation.

In all cases observed, the stripes cross the contours at right angles. Where the direction of slope changes, the direction of the stripes alters accordingly and they sometimes coalesce or bifurcate as the slope requires. The gradient of the striped ground is mostly near 20 degrees. The evidence would seem to confirm Hay's (1936) observation that the width of striping varies as the size of the coarse material but is inversely proportional to the slope. Further detailed measurements however would be necessary to confirm this point; it may also be that such variations are due to the original character of the debris, to the amount of peaty material introduced and possibly also to variations in ground-water conditions. All the evidence confirms the observations made by Hollingworth and Hay and supports their explanation of the stripes as being due to water drainage and frost heaving. The fact that no gullying is to be found on striped ground, however steep, suggests that they assist in the disposal of surface water and that this must be taken into account in explaining them. Only on the steepest slopes at the bottom of Maurice's Cleugh does wash give rise to runnels and very shallow gullies, but in that deep and sunless hollow conditions are quite exceptional and have given rise to a tongue of debris about 6 feet long and 2 feet high, closely resembling, on a miniature scale, the rock glaciers figured by Kessel (1941). The stripes have been visited after a period of frequent freezing and thawing weather, without rain, and many examples observed of material actually heaved into a position which wind and rain would quickly level again. In October 1951 about three square feet of stripes was dug to a depth of about a foot in the presence of a party of students. In March 1953, the extensive derangement of the stripes by the treading of

the party had been completely wiped out and perfect striping re-established on an area that had been heavily footmarked. The excavation, which had been left as a scooped-out hollow with spoil tailings below, was in process of obliteration, and stripes, though not fully formed, were present on the tailings. The phenomenon of striping, therefore would seem to be a contemporaneous and very active process though the material in which it is developed may have been produced by frost-shattering in a periglacial period. Indeed, the striping would appear to be subsequent to the erosion of the vegetative and peaty cover. Occasional clumps of heather among the stripes, with peat still held among the roots, indicate the relatively recent date of the erosion, while the disposition of the roots points to an active downhill creep of the surface material.

On the uphill side of many bare patches the peat and heather forms a low cornice in which can be seen the usual angular stones disposed often with their long axes down the slope and bleached by peaty acids. The present graziers of the hill have been in occupation for some thirty years and are not conscious of progressive erosion of the vegetative cover, but the O.S. 6-inch map of 1909 records a smaller area of bare ground than at present and that for 1862, the earliest edition, shows only a small area of denudation. To make a further test, a plot of two square yards has been deeply dug and levelled off and two similar areas have been superficially mixed and these will be visited periodically to observe developments. In the same area a line of some twenty-five white quartzite pebbles has been laid at yard intervals across a system of stripes. Excavations and other observations failed to explain why some areas though similarly denuded of vegetation were not striped. In many cases the material, slope and exposure were identical with striped areas and yet no observable pattern had developed.

The "inverted garlands" in the Dimple bear no resemblance to stone stripes (Plate 4). The material involved is exclusively rocky fragments, mostly of markedly flattened form and some 6–12 inches across. They are disposed in arcs convex uphill, with the long axes of the stones along the arc and the individual fragments lying on edge. The general appearance is as if the mass of rock fragments in their movement downhill had encountered an obstacle and were "flowing" around it. Excavation to a depth of 18–24 inches in the case of the garland, however, revealed no such obstacle, but showed the same predominance of large fragments and absence of the smaller and of peat. The underground structure then of the garlands, differs from that under stripes, but no reason can be seen for the difference. Stripes sometimes terminate at the uphill margin of a garland but do not recommence for some distance downhill of them. No explanation for the

Plate 1

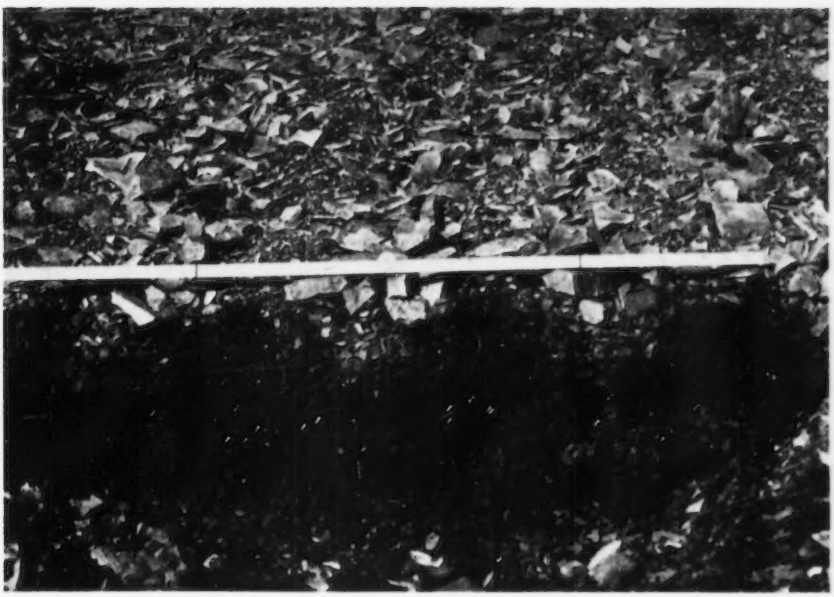


Plate 2

Plate 3

Plate 4

garlands suggests itself, though the peculiar jointing of the felsite, which here yields such flattened forms, may be significant.

Another interesting surface feature is a series of small rounded rock-points projecting through the peat and heather on the otherwise stoneless Scaut Hill (1923 feet) and apparently indicating a buried block-field. The presence nearby of a man-made cairn of large blocks supports this suggestion. There may be some relation to the "garlands" which lie only some 200 yards away, obliquely downhill.

The huge cairn on the summit of Tinto is in itself a problem. Marked by the Ordnance Survey as a monument, one may yet question whether man is responsible for the collection of such a vast weight of rock on a high summit devoid of any obvious source of loose blocks of such size and quantity. On the other hand, the summit may have carried a block-field as does Scaut Hill and this may have facilitated the human construction of the great cairn. However, it is conceivable that it represents the ultimate stage of decay of a natural tor and would therefore have to be reckoned with in arguments as to the existence of ice-free summits during the Pleistocene (Linton 1949). The few small pieces of sandstone among the otherwise exclusively felsitic blocks may be erratics or have been carried up by some of the many visitors to this commanding viewpoint. The occurrence of vitrified fragments of felsite also points to human interference but the presence also of lumps of tar or pitch suggests that the necessary high temperatures were developed in victory bonfires of modern times for which Tinto is a recognized site, rather than by the agency of prehistoric man, though there is a magnificent earthwork on the north flank of the hill and many other traces of prehistoric man in the surrounding country.

This would seem to be the first recorded instance of such stripes in Scotland. They not only offer a further field for study of such phenomena but demonstrate that striping is a contemporaneous process. It would seem to be necessary, in seeking an explanation, to neglect no part of the hill surface and to have regard not only to physical processes but to the possibility of interference by man.

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FROM THE *JOURNAL* A HUNDRED YEARS AGO

THE FOLLOWING EXTRACT is taken from a letter from Richard Burton, then a Lieutenant in the Bombay Army of the East India Company, describing his journey to Medina, disguised as a pilgrim. The letter was read to the Society on 12 June 1854 (*Journal of the Royal Geographical Society*, vol. 24, page 208).

"We embarked on board the *Golden Wire*, a pilgrim ship belonging to a Suez merchant. . . . The owner had agreed to take 60 passengers—a cargo quite sufficient, with their mountainous heap of baggage, for an open-decked vessel of about 75 tons. Favoured by fortune, he filled it with 130 human beings, mostly Badawin, from El Maghrab, perhaps the greatest ruffians in Islam. I will not describe the daily fights we witnessed and had sometimes to join in; two men were stabbed in the port of Suez, and before we were half way between Egypt and Yambu, the 'second class' generally made an energetic attempt to share with the 'first' the lofty poop of the *Golden Wire*: but we received them with our quarter-staves, and after an elegant little defence of our vantage ground we forced them to beat a retreat, their whity-brown burnooses bearing large stains of a certain 'curious juice.' Presently, in token of repentance, they kissed our heads, shoulders, and knees; they promised not to offend again, and during the rest of the voyage contented themselves with cursing us. . . .

"I might have saved myself all the hardships of this voyage by hiring a private boat; but two reasons prevented my doing this. In the first place it would have occasioned delay and expense; the smallest vessel would have cost me £50 or £60, and such a luxury would have argued great wealth, rendering proportionate expenditure everywhere necessary. Secondly, I had an unlimited confidence in the efficacy of a rice and water diet against the fury of the sun. Abstemiousness was my safeguard during this voyage, my subsequent journeys, and the pilgrimage time when my bare head and almost naked body were exposed to the fires of an Arabian September. As precautions I avoided washing, because warm water debilitates and cold gives fever; a little oil or melted butter, and occasionally a bath of lukewarm water and henna paste to cool the skin, were found amply sufficient. Against thirst I neither chewed bullets, nor washed hands, face, and feet, nor anointed my jaws with clarified butter, nor drank great quantities of liquid: the only remedy is patience, and after suffering for an hour or two the task is an easy one. When the skin is burned by the sun, white of egg cures the sore, which, if not attended to in these regions, may become an 'Aden ulcer'; and as in hot climates cold kills, it is as well not to be underdressed by day, and at night to sleep with a sheet drawn over the head as well as the body. Meals should be thus distributed: a very light breakfast on first awaking from sleep, a second light breakfast before noon, and after sunset a substantial supper of rice and dates, bread and garlic. In spite of Waterton, I assert that the traveller's best friends are pipes and tea; nothing more refreshing than the latter—nothing more soothing to mind and body, no more rational, thoughtful, and memorial occupation, than the former."

THE HEREFORD MAP IN FACSIMILE

THE WORLD MAP OF RICHARD OF HALDINGHAM IN HEREFORD CATHEDRAL. With Memoir by G. R. CRONE. (Reproductions of early manuscript maps, III). *London: Royal Geographical Society*, 1954. 20×25 *inches; 9 sheets; memoir and sheet of diagrams.* 70*s*

THE WORLD MAP of Richard of Haldingham is one of the greatest treasures of medieval cartography, so that it is an event of importance that now for the first time we have it for our pleasure and study in true facsimile. On a scale of about nine-tenths the original, and arranged in nine slightly overlapping sheets, the great map has been beautifully reproduced in collotype by Emery Walker, Ltd. A tenth sheet of line-drawn maps, illustrative of the derivations of this Mappa Mundi, has been added by Mr. Crone, who writes the accompanying scholarly memoir. The map was thus described in 1780 by the topographer, Richard Gough: "In the library of Hereford Cathedral is preserved a very curious map of the world, inclosed in a case with folding doors, on which are painted the Virgin and the Angel. It is drawn with a pen on vellum, fastened on boards, and is six feet four inches high to the pediment, and five feet four inches wide." One hundred years earlier an antiquarian had noticed it in the Cathedral, where it must have been since the early fourteenth century, but there appears to have been no earlier record of it. The Royal Geographical Society took notice of it at their first meeting in 1830, and soon afterwards had a hand-drawn copy made, which was however faulty in many details. It is upon this that later reproductions and commentaries have been based—the last by Konrad Miller nearly sixty years ago—so that the present new and accurate issue was certainly called for. All map-lovers, whether professional or amateur, must be grateful to the Society and to an anonymous donor for making it available today.

The initiative was taken in 1947 by Lord Rennell of Rodd during his Presidency of the Society. Himself a Hereford man, he had noticed and drew attention to the fact that the famous map was deteriorating. With the consent of the Dean and Chapter, therefore, the Society undertook its cleaning and repair (carried out at the British Museum), and provided a new oak case for its exhibition. This gave the opportunity for making the reproduction and writing the new memoir which is described by its author as follows: "This essay does not attempt to follow [previous scholars] in transcribing, identifying and commenting on all the legends and names. Its purpose, while amplifying and correcting their comments in some instances, is to give a description of the map and to place it in the general development of medieval cartography."

The authorship of the map has never been in doubt, for in a marginal inscription written in Norman French, the prayers of all who have, hear, read or see "cest estorie" are asked on behalf of Richard of Haldingham and Lafford "ki lat fet e compasse." Mr. Crone translates this as "who has made and drawn it," but the words do not necessarily bear quite this meaning. Richard may merely have designed it (it is very elaborate), for the high quality of the lettering, drawing and illumination suggest a professional scriptorium (such as presumably worked for Matthew Paris) rather than a cathedral Prebend—the office which Richard held successively at Lincoln, Sarum and Hereford. This however is a matter for the expert, and it is greatly to be hoped that now the map is easily available some medievalist will describe and comment upon its

numerous delightful drawings of men, animals and cities. Is it the author, for example, who under the motto "passe avant" is departing with a gesture of farewell from the right-hand bottom corner of the map, mounted on a fine dappled horse with remarkable nailed shoes? Is the procession of the blessed, who are being pulled rather forcibly into Heaven by an angel, a procession of portraits? The artist is evidently a humorist, for the swordfish in the Mediterranean Sea, called *miles maris*, has his sword jauntily tucked under his left fin. Perhaps the monstrous figures of the one-eyed, four-eyed, headless and dog-headed men, relegated to the remoter edge of Africa, should be accepted as figures of myth and fairy-tale rather than creatures supposed to exist in those parts. Two very unpleasant giants stand also in the path of Adam and Eve, who are being expelled from an island Paradise into the mainland of India.

The title of the map is given by a marginal inscription which reads: *Descriptio Orosii De ormesta Mundi, sicut interius ostenditur*. It is, that is to say, a map (*descriptio*) drawn to illustrate the popular *Historiae adversus Paganos* of Orosius. Its tradition is Latin, and this leads Mr. Crone to an interesting and informative discussion on the evolution of medieval Christian maps from Latin prototypes, a subject which owes much to the researches of the late Michael Andrews and Richard Uhden. Richard of Haldingham himself had no doubts as to the classical basis of his map, and following an old tradition, to be found, for example, in the *Cosmographia* of Ethicus, declares (in large Roman capitals all round the margin of his map) that Julius Caesar began the measurement of the habitable earth, and that its separate quarters were surveyed by Nicodoxus, Theodotus and Policlitus. This is further emphasized by a picture at the left-hand corner of the map of a seated Emperor handing out his sealed commission to the three surveyors named, bidding them bring to the Senate a measure of the contents of the Earth.

It is interesting to note how consistently the Cathedral Prebend looks backwards in time. Save for the introduction of a few topical names in France and Wales, and for a drawing (surely the earliest) of a far northern man on skis, the style and content of his map is that of five or six centuries before its actual date of *circ.* 1285.

Coastal outlines do not attempt to be representational. An oval sweep of the pen defines an island; Palestine needs more room, and so is thrust squarely out as a peninsula into the Mediterranean Sea, a device copied (as Mr. Crone demonstrates) from a much older map. Position was only "there or thereabouts" as space dictated. The famous well of Syene for example which Eratosthenes used in his measurement of the sphere, is placed near the banks of the "Western" Nile, and so in the centre of Africa, while the Welsh St. David's stands in the Marches. Yet the middle and later thirteenth century had been a period of remarkable cartographical advances. Matthew Paris had drawn his notable and detailed maps of Britain, which Richard of Haldingham had apparently never seen. In the Mediterranean region sailors were drawing marine charts to scale, basing them upon the measurement of distance and direction with the help of the magnetic needle. Among the Franciscan monks at Oxford a new mathematical school was rising, from which Roger Bacon drew inspiration for the world map which he presented to the Pope. This map had a network of latitude and longitude, upon which towns were marked precisely by red dots as they might be today. Richard of Haldingham was still using the symbols—drawings of towers and castellated buildings—devised by the Roman *agrimensores*. His scroll-like mountains were pierced by actual "gates" or "doors," carefully drawn, behind which Gog and Magog were still safely enclosed in north-east Asia where Alexander had left them. Richard had not,

as Roger Bacon had done, read the recent report of the journey of John of Plano Carpini, or talked with William of Rubruck. These travellers had found an open road to the very Gobi Desert, and Bacon believed that the Tatars among whom they journeyed were in very fact the evil hosts who according to prophecy would be unloosed on Christendom, so that the reign of Anti-Christ was at hand.

But the innovators in cartography were still only a tiny minority. Richard of Haldingham's Mappa Mundi was drawn in the fashion that the public expected to see, a fit ornament either for a king's chamber or a cathedral shrine. And as Gough tells us, "It served antiently for an altar piece," perhaps, since the Annunciation was painted on its cover doors, in the Lady Chapel.

E. G. R. TAYLOR

GEOLOGY AND THE EARLY HISTORY OF THE EARTH

THE EVOLUTION OF A SHRINKING EARTH: Anniversary address to the Geological Society, 1953. By G. M. LEES. (Extr. fr. *Quarterly Journal of the Geological Society* 119 (1953), 217–57.)

IN HIS ADDRESS to the Geological Society the President, Dr. G. M. Lees, examined the influence of geophysical ideas and speculation upon geological opinions on a variety of topics. He claimed that much of the speculative theorizing on the early history of the Earth's crust and on the processes which have given rise to the structural forms as we now see them has been influenced by geophysical conceptions which do not take sufficient account of the observed facts of geology.

Among these is the term "granitic layer" for which there is no justification in geological observations. The oldest-known rocks, believed to be about 2000 million years old, are metamorphic schists, gneisses and limestones; granites and other intrusive rocks form but a small proportion of the areas where these old rocks are exposed. Many of the metamorphic rocks were undoubtedly sediments which were derived from pre-existing rocks, so that the age of the Earth must be much greater than 2000 million years.

The geological evidence of the attitude of these older rocks of the crust makes it in the highest degree improbable that there can be a layered arrangement of the rocks in the crust such as seismologists have assumed to account for the transmission characteristics of seismic waves through them, or in making estimates of the amount of contraction which has occurred in certain folded mountain chains.

In several regions more than one system of Precambrian rocks have been proved of an aggregate thickness of at least 200,000 feet or nearly 70 kilometres; in most places these rocks dip steeply into the ground, and this over vast areas. The relations of these systems to one another prove that several periods of movement resulting in intense folding and crumpling have affected these regions, and there is simply not room in the thin crust of some 35 kilometres assumed by some geophysicists to accommodate these intensely folded structures.

These highly compressed regions of Precambrian rocks which occupy some millions of square miles of continental masses and underlie at comparatively shallow depths additional large areas imply great contraction of the crust since those rocks were formed. An examination of certain areas which have been folded since Cambrian times suggested to the President that there has been a contraction of the order of 1500 kilometres which is about three times the estimate made by Professor Jeffreys from geophysical considerations.

Turning to another topic, geophysicists believe that the Earth's crust below the oceans is radically different from that under the continents.

Yet in many parts of the world highly folded rocks strike boldly across the edge of the continent towards the ocean, *e.g.* the Atlas ranges in North Africa, the Hercynian in Brittany, England and Ireland. What becomes of these structures when they reach the Oceanic area? Do they double back on the continental shelf and rejoin the continent somewhere else as Stille believes or do they continue into and across the oceans?

Geophysicists rest their belief upon (1) gravity measurements and (2) the velocities of transmission of various types of seismic waves. The gravity argument runs something as follows. Numerous measurements of gravity show that the average value over the deep oceans is very close to that over the continents when both are assessed on the same basis. Since in the one case a depth of many thousands of feet below the station consists of water, while in the other the same depth consists of rock it is obvious that in order to give the same attraction the material below the floor of the ocean must be considerably denser than that which forms the continent and therefore must be a different rock. The seismic results are said to confirm this deduction. These indicate that there is in general less than 1 kilometre of sediments on the floors of the deep oceans, and that they are underlain by about 10 kilometres of a material in which the velocity of compressional waves is about $6\frac{1}{4}$ km. per sec., and that in turn by a different material of which the velocity is about 8 km. per sec. This sudden jump in velocity is termed the Mohorovičič discontinuity or colloquially the "Moho." Under the continents the "Moho" is at a depth of about 30 kilometres and in the rocks near the surface the velocity is about $5\frac{1}{2}$ km. per sec. It is this low velocity-layer which is believed to be absent from the deep oceans. There is, of course, a considerable risk in identifying certain rock types such as granite or comparable rocks, basalts and peridotites with these three velocities. As the speaker suggested, they may well correspond to changes of physical state in the materials at increasing depths below the surface. In any case this geophysical picture does not meet the argument that the known geological structures would require much greater depths than the above to accommodate them.

A review of ideas concerning the permanence or otherwise of ocean basins reveals that like the continents these have had a complicated and varied history and that it is not possible to speak of an ocean as if it were something unique. Geological explorations round the margins of the Atlantic show that the continental crust bends down seaward towards the depths of the oceans and there is no present evidence which sets a limit to the distance to which it extends. As the floor may consist over considerable areas of basalt, it is suggested that the existence of a low velocity continental layer might not be revealed to seismic explorations owing to the high velocity-layer which overlies it.

In the Pacific, continental-type rocks occur far inside its margins in many places, *e.g.* Fiji; further the eastern margin both in North and South America does not coincide with a permanent boundary between continent and ocean. The rocks which form the Rocky Mountains and the Andes give evidence that

they were derived from a land area lying to the west which is now beneath the ocean.

For these reasons and in view of upwarps and downwarps of 30,000 to 40,000 feet which have been proved in various areas by geologists it is impossible to maintain that the oceans have been permanent features of the Earth's surface.

With regard to the general course of Earth evolution it is estimated that the total amount of contraction which has occurred since early Precambrian time has been of the order of 3000 kilometres. If this figure is accepted the mean density of the Precambrian Earth would be about 4·5 as compared with its present value of 5·527, while the density of the primordial Earth would be much less.

Dr. Lees points out that Jeffrey's estimate of the contraction which has occurred since the Cambrian is based on the assumption that the Earth was once a molten globe which lost by radiation not only its original heat but also that produced by radioactivity within the crust.

He considers that the geological evidence which he brings forward supports the planetesimal hypothesis of the origin of the Earth proposed by Chamberlain and Moulton.

The whole tenor of the address is that an appeal to geological evidence in forming ideas regarding the past history of the Earth is to be preferred to a facile acceptance of geophysical speculations which are often founded on very imperfect data.

O. T. JONES

REVIEWS

EUROPE

LA MÉDITERRANÉE ET LE MOYEN ORIENT: Tome premier, LA MÉDITERRANÉE OCCIDENTALE. By PIERRE BIROT and JEAN DRESCH. *Paris: Presses Univ. Françaises*, 1953. $9\frac{1}{4} \times 7\frac{1}{4}$ *inches;* viii + 552 *pages; maps, diagrams and illustrations.* 2,200 *frs*

At comparatively long intervals—too rare, unfortunately, in geographical literature—there appears a book which achieves a major advance in technique, presentation and level of treatment. Of such a kind is the first volume of MM. Birot and Dresch's study of the Mediterranean basin, to be completed by a second volume as part of the collection entitled "Orbis." Here is a work that combines a measure of general treatment with considerable detailed exposition of topics for the specialist, and presents the results of extensive first-hand research and observation in relation to the wider regional background. The book has four parts: a general statement of physical and human aspects, and three regional sections—Iberia, Italy and French North Africa—the last of which is the work of Professor Dresch.

The first chapter, a discussion of structure in relation to relief, makes little concession to the non-specialist. Taking the theories of Argand, Kober and Stille as understood, the writer particularizes, to a degree hardly ever reached in a geographical text, the complexity and extraordinary variety in structural features that would seem to be characteristic of the Mediterranean basin.

Climate is not extensively treated, but there are several interesting maps relating to seasonal incidence of temperature and rainfall, which usefully expand and modify the current notion of "mild wet winters, hot dry summers." One might add at this point that the abundance, detail and generally high technical quality of the maps generally in 'La Méditerranée Occidentale' are a further merit of the volume.

It is probably in the domain of rural economy and settlement that MM. Birot and Dresch make their most important contribution. For Iberia there is a most valuable and illuminating analysis of the complex of historical, social and more strictly geographical factors that have produced such a varying response in agricultural exploitation: *huerta* cultivation, the Catalan *masia* system, the polyculture of Galicia and the Minho, and others. In Italy the contrast between the Po valley and the rest of the country is related suggestively to differences in climate, topography and hydrography; whilst for North Africa Professor Dresch examines problems of sedentarization of nomads, land tenure, and European colonization. One highly significant point emerges from the statement of conditions in Italy. The contrast in productivity and standards of living between north and south would appear to be far greater than can be explained by mere factors of physical geography; and it might therefore be suggested that many of the present-day ills of Southern Italy derive largely from purely social factors, and not from any intrinsic difficulty of environment —a conclusion in line with that reached for several non-Italian parts of the Mediterranean by other investigators.

The severity of human problems in French North Africa is also demonstrated: in certain parts, notably Algeria, European settlement is declining, with a slow but perceptible re-transfer of farming land to Arabs or Berbers. One effect of this is to intensify the failure of food supplies to keep pace with the rapidly growing indigenous population, since yields from European-held lands are higher than those from native holdings. Professor Dresch calculates that since 1871 the quantity of cereal foodstuffs available per head of population has fallen from 5 quintals to a present-day level of 2 quintals.

These samples may make clear the remarkable scope and depth of the joint study. Industrial development, a relatively minor matter in most parts of the Mediterranean, receives due attention, and the historical background of human occupation (*e.g.* Roman cultivation systems and early Arab colonization) has not been forgotten. The abundance of information, clarity and soundness of overall view make 'La Méditerranée Occidentale' an outstanding volume, and the appearance of the concluding part will be awaited with great interest and pleasure. W. B. F.

CAUCASIAN BATTLEFIELDS. By W. E. D. Allen. *Cambridge: University Press*, 1953. $9\frac{1}{4} \times 6$ *inches;* xxii + 614 *pages; maps and illustrations.* 70*s*

Between the Wars, Mr. Allen tramped and rode the wild marches of the Turco–Russian frontier in pursuit of knowledge and adventure. One result of his travels is this monument of a military history, describing in detail (with thirty-nine maps and an elaborate bibliography) the four major wars between Russian and Turk in the century between 1828 and 1919. The stage of these encounters was not really the Caucasus at all—to that extent the title is a misnomer—but the highland territory once known as classical Armenia, situated roughly between the Pontic shore and the two arms of the Upper Euphrates, and extending eastward as far as the sources of the Kura and the Aras. The Turks prefer to think of it as north-eastern Anatolia. This is a land subjected to the horrors of war and massacre for generations, so that the population is no longer

recognizable as Armenian or anything else. Here on a few mountain plateaus, and in narrow gorges, dwell many races—Turk, Armenian, Lar, Ajar, Georgian, Kurd, Circassian and Russian.

This book is a military history and of an almost startling objectivity. In his time the author has been able to prevail on both Soviet and Turkish authorities —no mean achievement—to allow him free movement over territory jealously guarded from most foreign eyes. His collaborator, Mr. Muratoff, was a distinguished Tsarist official, and he has many Turkish friends, gathered during a quinquennium spent in Turkey. In the result, his history emerges utterly without bias, and should be the delight of all those whose business it is to study the trends of strategy and the actual encounter of the battlefield. He has written the drama of what was in reality another Hundred Years War in four acts, with intervals. The reader will be surprised to find that Ottoman Turkey, even in the last century of her decline, was able so successfully to sustain the weight of war against Imperial Russia, and lose on the whole so little territory. In this book, rather refreshingly, there are no politics, and the deductions are of a military character. Across the stage pass most Commanders, great and small men, all admirably sketched, most of them little known to Western students. Of the Turks, Ahmet Mukhtar and Enver Pasha are probably the most interesting, of the Russians the most distinguished are Paskevich in the first of the four scenes and Yudenich in the last.

Another great point of interest is the extent to which the Russians found first-rate commanders among the Armenian subjects of the Tsar—Loris Melikov, Tergukasov, and Shelkovnikov, all in the third scene, are examples. Evidently the impression that the Armenians are a race mainly of traders and middlemen needs to be corrected. Shelkovnikov is described as the Skobelev of the Caucasian Army, and the only officer on the Russian side in the 1877–8 war to combine the qualities of a good staff officer with those of a leader of men. There is a thrilling account of his surprise diversionary march across the Alaja Dagh. On the Turkish side Mustafa Kamal appears only as a Corps Commander towards the end of the fourth scene, but the shadow of his fame looms even at this early stage. Of Enver Pasha Mr. Allen speaks disparagingly, regarding him as a reckless romantic who sacrificed his men to impossible causes. Yet he cannot deny the drama of the splendid Turkish failure before Sarikamish in mid-winter (1914–15), when the heroism of the *askers* came within an ace of realizing the plans of the dreamer who led them.

To many, the topography of Eastern Anatolia will be the leading interest, an interest which may well illuminate the future. There are few geographical tangles more confusing than these highlands with their ramified mountain systems and their parallel river valleys, one of which will hold a river running in exactly the opposite direction to the river in the next one. Here too rise rivers bound for three seas, the Black Sea, the Caspian, and the distant Persian Gulf; here are bare windswept highlands next to some of the most tangled temperate-region forests in the world. Here, lastly, is a patchwork of many races, crossed and recrossed over the centuries, the backwash of struggle between successive Roman, Armenian, Byzantine, Georgian, Persian, Arab, Mongol, Turkish and Russian protagonists. The reader may be surprised to find so little attention given to the Russian conquest of the main chain of the Caucasus itself. The reason for this will be found in the Preface; it is because that subject had been appropriated already by Baddeley, writing in 1908. But Mr. Allen includes as an epilogue an interesting account of the Red Army's conquest of Shamil's successors in Daghistan in 1918–19. Here again the topography is described in the clearest detail and is well illustrated in maps.

Military history is not light reading. But because it must be followed attentively with maps, it is peculiarly the field of a fellowship of explorers, many of whom will wish they could take up Mr. Allen's challenge. It is a challenge which has an obvious claim on the future. The use in an English book of the Turkish Roman alphabet for names within Turkey I find a little tiresome, *e.g.* Cemal Paşa for Jemal Pasha, Çoruh for Chorukh. The index is first rate. O. C.

VERMUYDEN AND THE FENS. By L. E. HARRIS. *London: Cleaver-Hume Press, 1953. 7×10 inches; 168 pages; maps and plates.* 21*s*

Mr. Harris has not attempted a full length study of Sir Cornelius Vermuyden, but though concentrating on the Great Level of the Fens, he throws a good deal of light upon Vermuyden's career in general. As a native of the Netherlands, Vermuyden was well acquainted with Dutch methods of drainage and reclamation, and also consulted his countrymen, but the author shows that Vermuyden was aware that the problems in the Fenland were not entirely similar, and vindicates him from much of the criticism to which he was later subjected. This partly arose from misunderstanding of the conditions in the seventeenth century, and partly from the fact that Vermuyden was prevented from carrying out his plans in full.

The book also makes a contribution to economic history, though its account of the organization of the "adventurers" who provided the capital, their methods of procedure, and the conflict between the various interest, local and national. Though what little is known of Vermuyden personally is not always attractive, he had many difficulties to contend with, and, on the evidence presented here, he deserves the rehabilitation he receives at Mr. Harris' hands. The story is complex, and not easy reading, but much thought and research has clearly gone to this study. G. R. C.

THE GOLDEN HONEYCOMB. By VINCENT CRONIN. *London: Rupert Hart-Davis, 1954. 8½×5½ inches; 267 pages; maps and illustrations.* 16*s*

Geographers, if they glance at this excellent book, may be surprised and even disappointed that Mr. Cronin was lured to Sicily by no more scientific an objective than a honeycomb. But Mr. Cronin's was no ordinary honeycomb. It was indeed no less than the golden honeycomb which Daedalus, prince of craftsmen, fashioned as an offering to Aphrodite of Erice. And the search for it led Mr. Cronin, starting from that famous sanctuary, to explore the island in all its historic and natural beauty and to unravel with delight the multi-coloured strands of the interlacing civilizations found there. The result is certainly no text-book of precise geological and geographical description. Nor is it that all too prevalent sort of travel book which records conscientiously, but without insight or emotion, every detail of the journey made. Mr. Cronin's book, his first, is a much rarer thing than that. It is a travel book rich in historical and geographical imagination by a writer, knowledgeable and sensitive, whose style, though a little baroque at times, is throughout intensely vivid. Every sentence evokes a picture of the land, of its ancient tombs and temples and Norman churches, of its sunlit fields, of the sauntering, gossiping crowds in the piazzas. In a way which should be the envy of the descriptive geographer, Sicily as a geographical and historical entity is brought to life. What matter if the honeycomb turns out to be no more than a symbol of the artistic riches with which history has endowed the island? Diodorus can be excused for telling, and Mr. Cronin for using, such a tall story when this admirable book is the result.

L. P. K.

ASIA

THE HIDDEN LAND. By URSULA GRAHAM BOWER. *London: John Murray,* 1953. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xx + 244 *pages; maps and illustrations.* 18*s*

The author has given us a book of special interest to geographers since it deals with the fringe of one of the very few considerable areas in the Commonwealth which are both inhabited and unexplored. The "Hidden Land" of the title lies west of the Subansiri river in the deep Sub-Himalayan belt which separates Tibet from the Brahmaputra valley. It consists of a remarkable upland valley some 500 feet above sea level, surrounded by a rim of 8000-foot mountains pierced only by one very narrow gap, through which the insignificant Kale river finds an exit, transforming itself suddenly from a placid stream to a mountain torrent roaring down to join the Panior river thousands of feet below. This valley is inhabited solely by the Apa Tani tribe, who are found nowhere else. These industrious folk have, in the course of many generations and without the aid of ploughs, which are unknown to them, transformed what was clearly a swamp into a great stretch of irrigated rice fields by methods of agriculture so exact and perfect that a population of about a thousand to the square mile is supported in reasonable comfort. All round the peaceful valley of the Apa Tanis lies, in vivid contrast, a tangle of wild hills, without an acre of level land except an occasional riverside flat little above sea level. The gentler slopes are scarred by the shifting cultivation of the Daflas and closely allied Miris. Unlike the Apa Tanis, who are too busy to be warlike, the Daflas in their small, scattered villages devote much of their energy to murderous raiding and counter-raiding.

In a preface which provides the background to her book the author explains why your reviewer was given the task of making good the McMahon Line and how her husband came to be posted in the hills. The McMahon Line here follows the crest of the Great Himalayan Range and is the boundary between India and Tibet. Of the country on the Indian side literally nothing is known over a long stretch, but there was reason to believe that Tibet was attempting to extend her influence and levy taxes well beyond the boundary and official Chinese maps made it clear that they claimed not only Tibet but the whole of the submontane belt on the Indian side and even a considerable slice of the Brahmaputra Valley. After an invaluable reconnaissance by Dr. von Fürer-Haimendorf the author's husband was made the first Political Officer of the Subansiri Area, with instructions to find out what he could, keep the Apa Tanis friendly, and pacify the warring Daflas sufficiently to make it possible for columns to pass through their country if need be.

The author accompanied her husband throughout and has a fascinating and exciting tale to tell. The country and its inhabitants are vividly described, with many striking pen-pictures of scenery and individuals. The illustrations are excellent, but the map is awkwardly bound in and the "blurb" on the dust-jacket is most misleading. J. P. M.

SOWJET-FERNOST. By ERICH THIEL. Veröffentlichungen des Osteuropa Institutes, München. Editor, Hans Koch, Band 1. *Munich: Isar Verlag,* 1953. 9 × 6 *inches;* 332 *pages; maps. DM*19.80

Professor Thiel's study of the Soviet Far Eastern territories forms the first part of a composite work on the Soviet Union now in preparation. It discusses in detail the population, geographic features, economic resources, and general development of the various sectors of the Soviet lands from Lake Baikal to the Pacific Coast, and the adjacent islands now under the Soviet flag. As befits a book from the pen of the Professor of Economic Geography in the University

of Munich, it is primarily a geographer's book and is not concerned with problems of government, politics or administration. Though much has been done since the inception of the Five-Year Plans to develop the mineral resources of the Soviet Far East and to attract settlers, the area as a whole is still underpopulated and undeveloped, and the local food supply has not kept pace with the growing demands. The total population is now only some six millions, and there is a marked tendency, as elsewhere in the Soviet Union, to move into the towns from the rural areas. Sakhalin, it is interesting to note, has tripled its population since the Japanese were expelled in 1945, Russian families replacing the former population of largely Japanese males. This work appears most opportunely to meet the demand for a reliable reference work (other than Russian works) on the vast Soviet hinterland to Manchuria and Korea, an obscure region on which curiosity is legitimately focused at the present time. It is well indexed and has a good bibliography of Russian and other specialist works on this region. V. C.

RICE. By D. H. GRIST. *London: Longmans, Green*, 1953. $8\frac{1}{4} \times 5\frac{1}{2}$ *inches;* xix + 331 *pages; illustrations and maps.* 35*s*

This is the first volume to appear in a new series of books on tropical agriculture which is being edited by Sir Harold Tempany; its author has had long experience in Malaya and elsewhere. A good book on rice (and this *is* a good book) is particularly to be welcomed by geographers, not only because of the fundamental importance of rice as a basis for whole civilizations, but also because rice cultivation is an excellent way of avoiding or overcoming many of the difficulties associated with tropical land use. These are familiar generalizations; but Mr. Grist's book is an excellent means of filling in the details and of correcting a number of common misapprehensions. There is, for example, a thorough and far-ranging review of irrigation, of methods of cultivation and of fertilizers, in the course of which the reader will come to realize that indiscriminate mechanization and the application of fertilizers are by no means the panaceas for rice cultivation which they are sometimes made out to be.

The author appears however to be unduly influenced at times by his Malayan experience; he tends for instance to think too exclusively in terms of "bog soils" and excess of water, both rare in the many rice-growing areas which suffer seasonal drought. He is also not fully at home, it seems, when dealing with the human factor. The problem of synthesizing a vast mass of material is not always satisfactorily solved, especially in the earliest chapters; "a bacteria" and "irrigable water" are examples of errors which have gone uncorrected; and, although the book is extremely well illustrated with photographs, it could do with more maps. These however are small criticisms; Mr. Grist's 'Rice' deserves to be very widely and very thoughtfully read. B. H. F.

SOVIET EMPIRE: the Turks of Central Asia and Stalinism. By OLAF CAROE. *London: Macmillan*, 1953. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* x + 300 *pages; maps.* 25*s*

It is time that an authoritative book was written on Russian Central Asia about which very little information today leaks out to the rest of the world. The author had a distinguished career in India and has now been devoting time to the compilation of information on Russian Turkestan much of which is from Soviet sources and therefore all the more revealing. He has also studied the writings and sayings of various *emigrés* from Turkestan, who have taken refuge in Turkey in recent years, notably Professor Togan. *Emigré* views are often warped and unreliable but the author has used this information with discretion.

Russia moved into Central Asia originally because this was the final stage of

an expansion which had begun as far back as the reign of Ivan the Terrible. It was an attempt to set up stable frontiers and eliminate nomadic raids which had plagued Russia since the thirteenth century. But in so doing Russia found herself responsible for millions of Asiatic people whose religion, history and culture were entirely different to her own. Unless she advanced still further and came to the gates of India and so raised dangerous international issues, she would have to stop. But it was equally dangerous to leave the Turkestanis on the edge of the Russian Empire, if they were likely to be attracted to the fellow Islamic civilizations outside. So a policy of russification and the shutting out of all foreign influences from Turkestan was forced on Russian rulers, whether Tsarist or Soviet. This russification has only really commenced under the Soviets but Sir Olaf describes its beginnings under the Tsar.

In an interesting chapter on the Turanian Basin the author goes into the whole question of the geography, past and present, of Turkestan. The theory has long been held and has been backed up by recent historical evidence that the Sir Darya and the Amu Darya once flowed into the Caspian Sea. Flourishing trade then took place between South Russia, North Persia and the Caucasus with the oases of Turkestan along this water route. Tsarist engineers first drew up plans for rebuilding this old waterway by cutting a canal through the Kara Kum desert to the Caspian. What caused the alteration of the course of these two rivers is not clear but there is some evidence of the gradual drying of the climate and of lower levels today in such lakes as Issik Kul compared with former times. Soviet Russians try to make out that a big earth movement in Tertiary times caused a diversion of the waters. Soviet philosophy must have it that only Soviet Man can solve this problem and will not acknowledge that people before them have had any ideas on it.

The decline of the economic importance of Turkestan is traced by the author to important historical causes. After the foundation of the Mongol Empire Kublai Khan, the ruler of China, and Hulagu Khan, the ruler of the Middle East decided to open up the sea routes between their respective dominions. This and the Portuguese discovery of the sea route round the Cape caused the caravan routes through Central Asia to decline.

What held the people of Turkestan to those of the Middle East was Islam. The increasing geographical and economic isolation of Turkestan as the centuries passed tended also to isolate the religion of the people from outside contacts and to develop a fanaticism which became typical of Bokhara and Khiva. The isolation was intensified by the Soviets who feared, even more than Tsarist Russia, contact of the people of Turkestan with the outer world. Systematic attempts were made to prevent them from developing a language which would serve all Turkestan. At all costs their culture must be fragmented in order that Russia might rule.

The author touches at the end of the book on the future. It is not impossible, he seems to think, that an intelligentsia might arise (indeed may be there now) unaffected by Marxist dogma and who might take the lead, if new developments took place in Soviet Russia itself, leading to a lessening of Moscow's hold on the periphery of the Union. "Marxism-Leninism," he says, "is in no sense a child of a Russian and Turkish liaison. . . . Marxism is the result of systematic western social philosophy in the hands of able and embittered men on the double-storeyed, ill-cemented Russian society, whose Byzantine framework was outworn and whose trappings had begun to disappear as tinsel to men who had lost their direction." This Marxist Byzantine system is now riveted on the ancient cultures of Central Asia. The value of Sir Olaf's book is that it gives us chapter and verse of how it happened. M. P. P.

AFRICA

FOUR GUINEAS: A journey through West Africa. By ELSPETH HUXLEY. *London: Chatto and Windus*, 1954. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xii + 303 *pages; maps and illustrations.* 21*s*

In her usual vigorous and entertaining style, Elspeth Huxley describes a journey through British West Africa. The descriptions are delightful, the reviewer remembering particularly those of a Wolof woman and of an Accra market mammy. There are 59 magnificent illustrations, all but five taken by Mrs. Huxley.

This account however is more than the usual travelogue, for the author buttresses her vivid analysis with references to such authorities as Rattray, Bowditch, Frobenius, Bovill, Ward and Meyerowitz. Consequently, the account is more satisfying to those who already know West Africa. And for those who do not, the book is also more useful because there are passable maps and better summary notes on each territory before the author's account.

Mrs. Huxley is most successful in describing the Gambia and Sierra Leone, less successful with Nigeria and the Gold Coast. This is, perhaps, because she examines West Africa through the eyes of a European steeped in East Africa. On occasion, she gives the impression that she has a mission to disapprove, particularly of political matters. It is not surprising, therefore, that in such things she makes some misstatements of fact. There are also some which geographers will notice.

Nevertheless, this is not only a very colourful and arresting account of British West Africa but generally a true and kindly one. R. J. H. C.

SUKUMALAND: An African people and their country. A study of land use in Tanganyika. By D. M. MALCOLM. *Oxford: International African Institute (Geoffrey Cumberlege, O.U.P.)* 1953. $9 \times 5\frac{1}{2}$ *inches;* xix + 224 *pages; illustrations, maps and plans.* 30*s*

This book is the outcome of an investigation into the maldistribution of population in the four Sukuma districts in the Lake Province of Tanganyika Territory. It is emphasized that the Sukuma are primarily agricultural, and that cattle are "adventitious to the original economy," introduced, it is said, by the pastoral Huma from the west. Their population is about one million, and they have some 1,900,000 cattle-units, a cattle-unit being either one head of cattle or five head of sheep and/or goats; as they are an agricultural rather than a pastoral people, the inclusion of all types in one unit does not matter from the ethnographical point of view. Bride-wealth was formerly paid in hoes, but latterly in cattle; and the Sukuma are another instance of an agricultural people who pay a higher bride-wealth than pastoralists like the Masai. The Sukuma have a custom called *kubirisa*, that is, lending stock to friends, in some ways analogous to the *kaptic* system of the Nandi; but we are not told in what circumstances their return may be demanded.

We are given a comprehensive survey of the land, its use, and problems, with some introductory matter on hereditary and elected authorities, and on the life of the people. The chieftainships seem to be due to conquest by Huma (Hima) from Ruanda, Urundi and Bukoba. The manner of succession is somewhat obscure, and might have been explained in a little more detail; it is clear however that a chief could be expelled. A short account of the use of the land for agriculture and stock occupies pp. 50–82; this is followed by a section on the administration of Local African Government. Under a previous system each of the four districts had its own federation of chiefs; latterly all the chiefdoms

have been formed into a single federation with a central headquarters; and the description of the functions of the Native Authorities is an important contribution to the administrative aspect of a modern African people.

The last quarter of the book deals with the provision of surface-water catchment works, and contains an extremely interesting and useful study of the soils of the country, with their Sukuma names, capabilities, and natural vegetation cover. The material collected here should be of more than purely local value, for it can provide many useful and helpful suggestions for application in the rehabilitation of other inadequately watered parts of East Africa; especially pp. 148–73, in which is given a detailed description of the construction and maintenance of surface-water catchment works illustrated with diagrams and photographs. The remarks on the extension of land under cultivation and the use of ploughs (pp. 126 *et seq.*) are worthy of attention, and it is noted that the Native Authority has introduced measures for the control of ploughing. The author foresees the coming of mechanical cultivation, which he suggests could be worked through some such means as the existing cooperative organizations of the working age groups in Sukuma villages, a safer and more efficient system than plough tillage entirely in the hands of individuals.

The maps, some coloured, include physical features, vegetation, rainfall, and soils. The book is well produced, and has an adequate index. We hope that similar books will appear on other tribal areas in East Africa. G. W. B. H.

RECENT TRAVEL IN AFRICA

KALAHARI SAND (*George Bell*, 1953, 15*s*), by Professor Debenham describing two visits to Bechuanaland, the purpose of the second and longer expedition being to report on the possibilities of growing beef in the Kalahari. In no sense a detailed report of the mission, the book gives a general picture of the Protectorate. Professor Debenham describes the inhabitants, vegetation, game and insect life of the areas he visited in a way which is always entertaining and often amusing. As a result, 'Kalahari sand' provides an excellent background to any detailed study of the region. There is an interesting chapter on the Okovango swamps where, in contrast to the rest of Bechuanaland, the problem in development is to deal with an excess of water. Professor Debenham suggests in broad outline a comparatively inexpensive pilot scheme for swamp control, using local materials, which has the advantage of being easily reversed should the experiment fail. The last chapter, entitled "Excursion into science," discusses in more detail the water resources of the Kalahari, methods of water tapping, and means of storage. The need for further study and for pilot schemes is again stressed. Finally, Professor Debenham summarizes the possible future resources of Bechuanaland, which he thinks may include a widespread pastoral industry, capable of supporting a human population of perhaps one to the square mile, in what has up to the present been known as "desert."

In RAINBOW ON THE ZAMBESI (*Museum Press*, 1953, 15*s*), D. Taylor, a journalist, describes a journey he made recently to Central Africa to investigate the case for Federation. Those who hope to find an objective balancing of the pros and cons of Federation will be disappointed. Mr. Taylor reports conversations held with various political leaders and Government officials, and with stray acquaintances met in hotels and aeroplanes. These reported conversations include talks with several Africans, at least one of whom (the Paramount Chief of the Barotse) has definitely pronounced in favour of Federation; while most Europeans to whom Mr. Taylor spoke also supported it. On this rather slender evidence, assisted by the news that the Bishop of Mashonaland has announced that an inter-racial social club may soon be formed in

Southern Rhodesia, Mr. Taylor is confirmed in his belief that Federation, coupled with a high rate of immigration from Britain, will build a new multi-racial Dominion capable of "saving Africa by her own example." Mr. Taylor admits that he has not in his book made an exhaustive examination of policies and economics, for he considers that "the fate of Federation in Central Africa depends on people and not, in the end, on pieces of paper." The value of 'Rainbow on the Zambesi' lies in its fair representation of at least the superficial views of administrators, settlers and other Europeans in Central Africa. The danger is that the casual reader may neglect other aspects of the problem not dealt with by Mr. Taylor.

The author of BLUE VEILS, RED TENTS (*Hutchinson*, 1953, 21*s*), claims no detailed knowledge of the Sahara and its inhabitants. Mr. Gardi's is a straightforward story of the adventures of himself and his companion after the abandonment of the impressively named "Swiss Hoggar Expedition" following the sudden liquidation of the tourist agency which had arranged it. With only slender resources the two managed to reach the Hoggar, where they stayed with the Tuareg owners of the 'Blue veils, red tents' of the title; and by travelling rough they undoubtedly saw more than the usual tourist does. Although in no sense a contribution to the geographical or ethnographic literature on the Sahara, 'Blue veils, red tents' might interest the traveller who intends to make a quick trip across the desert.

The publisher declares MIRAGE OF AFRICA (*Hutchinson*, 1953, 18*s*), "more than a straightforward travel-book." Certainly the author touches on many subjects outside his journey from North Africa to Fort Lamy and Lake Chad. Much of the book is devoted to pre-history, and Mr. Brodrick makes interesting observations on possible links between African and West European examples of prehistoric art. The numerous photographs are excellent. J. M. R.

POLAR

PORTRAIT OF AN ICE CAP. By J. M. SCOTT. *London: Chatto and Windus*, 1953. 8 × 5 *inches; 173 pages; illustrations. 12s 6d*

A human portrait represents the views of one artist. This portrait gives the feelings of one expedition about the Greenland ice cap. It retells part of the story of the British Arctic Air Route Expedition of 1930–31, of the efforts to establish and maintain an ice cap meteorological station, of the lonely five-month vigil of Courtauld in the centre of the ice cap, and finally of the anxious search to find the station the following summer and relieve Courtauld if he were still alive. The story is one of men and the elements, told almost entirely and with considerable effect by selected extracts from the diaries of the principal participants. The background is provided by a short account of the simultaneous struggle of a German expedition farther north on the same ice sheet, by a brief mention of earlier and of later expeditions to Greenland, and by an introductory page or so about the physical characteristics of this mass of ice.

The book does not draw on the post-war studies of this area to help the canvas. The technical onslaught of the "Expéditions Polaires Françaises" during 1949 is mentioned but rather as a glimpse into the future. Their techniques and results have altered the incidental background of the canvas and date this book as a pre-war story, even though the struggle of man with nature remains. The book, which is pleasantly produced with photographs lacks a map of any description. While it does little to inform or add to our knowledge of ice caps, it can be recommended as an exciting book for an evening at the fireside. G. DE Q. R.

QUEST FOR A NORTHERN AIR ROUTE. By ALEXANDER FORBES. *Cambridge, Mass.: Harvard University Press (London: Geoffrey Cumberlege). 9½×6 inches; 138 pages; maps and illustrations. 32s*

In the spring of 1941, the United States Government decided to establish a chain of air fields in the north of the continent so that fighter aircraft might be flown to England rather than run the risk of being sent to the bottom if shipped across the ocean. It is the story of the establishment of these bases which Dr. Alexander Forbes tells. Ten years before, at the instigation of Sir Wilfred Grenfell, Dr. Forbes carried out an aerial survey of the Labrador coast north of Nachvak Fjord, the resulting map being published in 1938. As the result of a private letter from a friend in the U.S. Army Air Corps, Dr. Forbes, who was then serving as a Lieutenant-Commander in the Naval Reserve, came to Washington to meet General Spaatz to discuss the proposed bases, and was appointed to the venture as "technical adviser." A reconnaissance flight with Captain Elliot Roosevelt in command was made up the Labrador coast to Ungava Bay and the site for the first airfield (to be known as Crystal One) was chosen at Chimo.

In September 1941, a fleet of trawlers and an Army Transport proceeded north to establish the base at Chimo and in Baffin Island. Dr. Forbes was sworn in as an Arctic Pilot in the Civil Service for the voyage. In spite of the lateness of the year the ships succeeded in successfully unloading men and materials all of which had to be transported a further 5 miles up to Koksoak River in small boats. After Dr. Forbes came back to the Navy (which incidentally he found he had never left) he returned to applying his studies of physiology to war-time needs but without success and by the middle of January 1942 had managed to become attached to the Hydrographic Office in Washington. From this vantage point he was able to keep up to date with developments in the Arctic. Difficulties of navigating large ships in uncharted water soon manifested themselves and Dr. Forbes was called to the War Department. Two Norwegian sealers, well known to Arctic travellers, *Polarbjorn* and *Quest* had already taken part in establishing the base at Chimo and in the second part of the book we meet Captain Bob Bartlett in his fifty-year-old schooner *Morissey* who with Dr. Forbes carry out a detailed survey of the approaches and harbours of the new air bases. It is indeed good to read of Captain Bob's war service; in 1909 he had reached within three degrees of the North Pole with Peary and yet thirty-three years later he is still voyaging to Arctic waters as game and as young as ever. By 1943 he had completely overcome any irritableness and lack of humour which the military demands had first occasioned in 1942. Surveys were carried out, of Frobisher Bay and the Koksoak River, without which unquestionably some ships would have been lost. As it proved ultimately, this intensive war effort was unnecessary; the beating of the U-boat by the Royal and U.S. Navies removed the necessity for these fighter bases, but geographical knowledge of the area has been considerably enriched.

The book is a straightforward account of this great effort with sufficient technical detail to explain scientific methods; there is humour too. Camp life seemed to cause numerous complaints among the ratings. "I was inclined to ask the Bureau of Personnel for physical giants all guaranteed proof against piles, psychoses, neuroses, headache, heartache, backache, homesickness, malaise, sciatica, lumbago, rheumatism, germs, toxins, muscle strain and mosquito bite." On returning from Mitchell Island, Dr. Forbes remarked to his companion, an enlisted man, "This is a fascinating island, isn't it?" The boy looked amazed. "Don't you see anything in it?" "No." "What sort of island would

you like, one studded with palm trees?" "One with lots of women on it." There are adequate maps and interesting black-and-white illustrations. There is no index and 32*s.* is a high price for 138 pages. Q. R.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

MORPHOLOGICAL ANALYSIS OF LAND FORMS. By WALTHER PENCK. Translated by Hella Czech and Katherine Cumming Boswell. *London: Macmillan*, 1953. 8½ × 5½ *inches;* xiv + 429 *pages; plates and diagrams.* 42*s*

To review Penck's revolutionary work in geomorphology nearly thirty years after his original account of it appeared would be quite out of place. His 'Morphologische Analyse' has long since established its position as a classic in its field. It will suffice to record that the book is at last available, in a scrupulously careful translation, to English-speaking geologists and geomorphologists. To make easy English reading from Walther Penck's German would take a master of English with an exceptional knowledge of German, and the tautology of the English title alone shows that the results achieved by Dr. Czech and the late Miss Boswell are not ideal. But they are adequate. And, in her able summaries of Penck's chapters, which she appended to the book, Miss Boswell unintentionally raised an imposing monument to herself.

To one trained in the school of Davis, Penck's work is a release from bondage, for Penck felt the energy within the Earth's crust whereas Davis seemed merely to apply the forces of erosion to the outer shaping of dead rock. In Penck's hands, too, geomorphology belonged properly to the realm of geology, not to geography. The appearance of an English translation of his book may lead to the revaluation of the work of a few original students of the subject, like the late E. C. Andrews (see *Geogr. J.* 86 (1935) 183–4), who sought in crustal dynamics the reasons for the underlying unity of control of geomorphological processes. M. A.

BRITISH CAVING. An introduction to speleology. By members of the Cave Research Group, edited by C. H. D. CULLINGFORD. *London: Routledge and Kegan Paul*, 1953. 9½ × 6 *inches;* 468 *pages; plates and diagrams.* 35*s*

It is always pleasant to meet a book which satisfies what has been succinctly if uneuphoniously described as "a felt want." This 'British Caving' unquestionably does, and with great success. Indeed, it satisfies three wants at once, for in its 468 pages it combines a long-needed review of the natural history of caves in general, a comprehensive guide to British caves in particular and an up-to-date account of the specialized techniques now used in cave exploration. The editor admits of a duality of aim, stating that the work has been produced both "to give the expert an accurate and detailed account of the scientific and technical aspects of caving" and also "to introduce the reader who is not a scientific expert to a fascinating new study." The reviewer, no expert on caves, felt on completing the book that the producers had brought down both their birds triumphantly. 'British Caving' is an important book for the gap it fills in our literature, but it is noteworthy above this for the range and authority of its information, its readability and the attractiveness of its presentation.

The text is arranged in two Parts, the first dealing with scientific aspects of caves and their distribution in Britain, the second with the practical techniques of their investigation. The opening five chapters, covering the modes of origin and evolution of caves, are contributed by Dr. G. T. Warwick, of the Department of Geography in Birmingham University. Chapter 1 treats briefly the basic geological factors of lithology and structure which permit and influence

cave development. In Chapter 2 attention is turned to the agencies which excavate caves and a general treatment of ground-water is extended by consideration of the influences exerted on its movements by surface relief, progressive valley deepening, drainage rejuvenation and glaciation. Caves are here shown in their true meaning as the products of general denudation operating in rather special circumstances. In Chapter 3 Dr. Warwick reviews the various alternative theories that have been advanced to explain the mechanisms of cave formation in limestone areas, and concludes, as did W. M. Davis twenty-five years ago, that we need a great deal more careful collection of facts before we can reach any confident decisions between them. There follows an interesting account of the many different types of cave deposits and depositional formations, and Dr. Warwick's section ends with a chapter reviewing all the British caving regions, supplemented by an extensive bibliography. These five chapters give us in small compass an excellent summary of the geomorphological aspects of caves, although sea-caves, no doubt by design, receive very little attention.

The remaining chapters of Part I take the geographer on to less familiar ground. A brief study by Nellie Kirkham deals with caverns broken into by old mines, and warns the amateur of the dangers of entering abandoned mine-workings. There follows an interesting chapter by J. O. Myers, of Leeds University, entitled "Cave Physics," which covers the circulation of air in cave systems, atmospheric conditions in them, unusual water-flow conditions, methods of tracing underground water-connections, and the application of geophysical methods to "prospecting" for underground caverns. In Chapter 8, J. W. Jackson gives an account of archaeological and palaeontological discoveries in British caves which, although inevitably taking on in some part the character of a list, affords a valuable reference collection. Part I is concluded by two chapters on natural life in caves; one by Mary Hazelton and Brigadier E. A. Glennie on cave flora and fauna, the other by W. M. and J. H. D. Hooper on cave-dwelling bats. The general reader is astonished at the wide range of life that has been found far underground and impressed by the skill and persistence that has been devoted by enthusiasts to its study.

In Part II the emphasis shifts to practical matters. A brief outline of the history of cave exploration in Britain by J. J. Dunnington is followed by three chapters by C. E. Railton on methods of discovering new caves and preparing for their exploration, on equipment and its use, and on procedure during exploration. For experienced caver and amateur alike these chapters, clearly written and effectively illustrated, offer a wealth of sound counsel by an acknowledged expert. There follows a chapter by F. G. Balcombe on the hair-raising pursuit of diving through water-filled passages. Here, as in other fields, the new light diving equipment developed during the war has been applied with great success, and not only to the penetration of hitherto impassable barriers but to scientific study under water. Three final chapters by Messrs. D. A. Coase, A. L. Butcher and Norman Thornber give practical advice on cave photography, the survey of cave systems and safety precautions and rescue work. Appendices cover a code of speleological ethics, a glossary of caving terms, a list of caving organizations and a comprehensive list of known British caves, the latter being pin-pointed by their grid references.

The field covered by this book is wide, and with so many contributors there are inevitable differences in style and treatment, but the editor has succeeded in maintaining a good balance and all sections are clear, interesting and readable to the non-specialist. Each chapter has a useful bibliography and the whole volume is richly illustrated with admirable photographs and line drawings. The

type is exceptionally clear and the format pleasing. All concerned are to be congratulated on a book both scholarly and fascinating which seems certain to remain for many years a standard work in its field. R. F. P.

THE CLIMATES OF THE CONTINENTS. 4th edition. By W. G. KENDREW. *Oxford: Clarendon Press*, 1953. 9 × 6 *inches;* 607 *pages; maps, diagrams, tables.* 50*s*

The fact that this work has doubled in size since it first appeared in 1922 reflects not only the vast increase of observational material but also the author's extended travels and his opportunities for research in the meteorological offices of every continent. The chapter on Antarctica which first appeared in the second edition has been revised in the light of current knowledge, but one wonders why there is no section on Greenland which might have been included with the North American continent as logically as New Zealand with Australia or Indonesia with Asia.

Lucidity of exposition, always a characteristic of Mr. Kendrew's works, was never more apparent than in the present edition, in spite of the detailed mass of climatological statistics requiring explanation on theoretical principles. He throws fresh light on the question of the suitability of the highlands of Kenya and Tanganyika for white settlement, arguing that the intense glare of the tropical sunshine with its high actinic power at 6000 feet has injurious effects, especially on the nervous system (p. 100). A table on p. 332 showing for places in Central Europe the months with snow on more than half of the days with precipitation and those with no appreciable snow contains a glaring error, doubtless through oversight, in the statement that at Groningen, Holland, no snow falls in December and January, of all months. If the prohibitive cost of this volume could be reduced substantially by the elimination of some of the diagrams it would be well worth while. It seems unnecessary to translate into graphs so many tables showing the annual course of the climatic elements, for surely it may be assumed that readers capable of taking an intelligent interest in the subject would have a very clear mental picture of the relative positions occupied by the months of the year with respect to the sun—December opposite June, March opposite September and so on. L. C. W. B.

PIONEER PLANT GEOGRAPHY: The phytogeographical researches of Sir Joseph Dalton Hooker. By W. B. TURRILL. (Lotsya: a biographical miscellany, ed. Frans Verdoon, Vol. 4.) *The Hague: Martinus Nijhoff*, 1953. 9½ × 6¼ *inches;* x + 267 *pages; illustrations.* 19 *guilders*

To a modern botanist, Joseph Dalton Hooker is one of the giants of the Victorian era. The astonishing breadth and quality of his work is recognized at least as much by his successors as by his contemporaries. In 1881, when President of the Geographical Section of the British Association, Hooker chose as his subject "On Geographical Distribution," a study to which he himself had already largely contributed. Dr. Turrill's book is concerned solely with this aspect of Hooker's work and so will be of especial interest to geographers.

Hooker had the good fortune to be born into an age when Britain was at her most expansive and nations vied with each other in bringing back new discoveries from the remote quarters of the globe. He certainly did not waste his opportunities or fail to give good return for them. Immediately after taking his M.D. at Glasgow, he joined Sir James Ross's Antarctic expedition. Three years were spent in southern waters, not without great danger when sailing amongst the icebergs in the region of the Great Barrier. The numerous specimens brought back from this expedition formed the basis for the 'Flora Antarctica,'

the 'Flora Novae Zelandae' and the 'Flora Tasmanica.' The introductory essays to these three works contain lucid expositions of the geographical relationships and origins of the floras of the southern hemisphere which are still quoted in modern discussions of these problems. Hooker was led to the view, as many other botanists have been since, that only the previous existence of a continuous Antarctic or sub-Antarctic continent can explain the common element that is found in the floras of New Zealand, Australia and southern South America. He discovered, too, the close similarity between the floras of Tasmania and Victoria and regarded the former as recently separated from the latter, an opinion which has been fully endorsed by geological evidence.

While the publication of his Antarctic work was still in progress, Hooker made another expedition, this time to the northern frontiers of India. It was beset by political difficulties and he and his companion were imprisoned for some time by the Rajah of Sikkim. Nevertheless, Hooker worked with characteristic energy and his essay "A sketch of the flora of British India," prepared for the Imperial Gazetteer of India, has not yet been replaced as a summary of the flora of this enormous area. Two smaller expeditions followed, the first to Palestine and the second to Morocco. His last expedition took him to North America where he travelled extensively in the Rocky Mountains with the American botanist Asa Gray.

Dr. Turrill's book is mostly by Hooker himself. The author has provided the cement which binds together long extracts from Hooker's papers and journals. This does not make for easy reading, but it would be unfair to criticize the author because he was asked by the editor to cast the book in this form. No one could have performed this exacting task better than Dr. Turrill, who has inherited at Kew the Hooker manuscripts and collections and who himself is an eminent botanist and plant geographer. Hooker's expeditions have not been taken in chronological order; instead the material is arranged geographically, so that the reader begins with Hooker's speculations about the distribution of Arctic plants and proceeds by way of the Old World and the New to Antarctica. This has the disadvantage that the final paper to be discussed was published before the first, but since the purpose of the book is to treat of Hooker's contributions to plant geography rather than the development of his ideas, this probably matters little. At the end of each section Dr. Turrill has added notes of subsequent work, which will be invaluable for students of the subject.

The book includes photographs of several of Hooker's original field sketches preserved at Kew. They reveal Hooker as no mean artist and the Indian sketches convey a marked oriental quality. P. B.

THE STORY OF THE OCEANS. By JOHN SCOTT DOUGLAS. *London: Frederick Muller*, 1953. 8×5 *inches; 272 pages; illustrations.* 15*s*

Some 200 pages of this book are concerned mainly with the plant and animal life of seas, coasts and islands, and it consists rather of a popularized account of marine biology, coloured by the author's own anecdotes, than a story of the oceans. The first part of the book, before the author gets safely among the animals, is often misleading and inaccurate.

Captain Phipps made the first deep sounding during his voyage to the Arctic, not during Captain Cook's second voyage. Maury's work described on page 16 was important, but in this connection there should have been some mention of Rennell's work and Findlay's Sailing Directions. Darwin retired to Downe not Downs, and the Braille sounding device mentioned on page 22 is presumably the sounding rod devised by Lieutenant Baillie, R.N. The northward

drift of Greenland mentioned on page 26 is questionable; there is a misprint for calcite on page 29.

The account of tides on page 37 is grossly oversimplified. The actual tides do not fit the equilibrium-tide model, and South Atlantic ports do not have high tide at the same time as North Atlantic ports in the same meridian. There is some misrepresentation and confusion on the subject of waves, seiches, "normal tidal swells," and rip-tides. One of the worst statements in the book is on page 56, where the author attributes the flow of the Gulf Stream to the spreading of water as it expands: he does not even attribute it to a process of convection, still less to the effect of the wind which has been the accepted explanation for a hundred years.

Objecting to an early explorer's "tall story" of six months' day and six months' night in the polar regions, he says there are "some hours of darkness in many of the summer months." This is misleading: so are his ideas on water and heat transport (page 60) and his idea of a cold current sweeping northwards along the west coast of Australia on page 65.

It is quite an interesting book, but some of the first part has to be taken with a pinch of salt. G. E. R. D.

SOME RECENT NATURE BOOKS

Sponsored by the New York Zoological Society and the Conservation Foundation, Dr. A. Starker Leopold and Dr. F. Fraser Darling have published a report on their journeys of observation in Alaska undertaken in 1952. The book, entitled WILD LIFE IN ALASKA (*Ronald Press Company, New York*, 1953, $2.75), is concerned particularly with the status of caribou, moose and reindeer and their place in the future economy of Alaska. Mention is also made of some of the sociological problems presented by the Eskimo and Indians, and the final chapter is devoted to suggestions as to the management of big game animals in Alaska. The report provides a concise and interesting study in ecology and conservation, of considerable general interest and of considerable importance to those desiring information on the economy of Alaska and its future development. The work is illustrated with photographs and figures, and there is a bibliography of some fifty references.

On an altogether much larger scale is Mr. James Fisher's "New Naturalist" monograph THE FULMAR (*Collins*, 1952, 35*s*). This magisterial study of an interesting sea-bird contains much that will interest the geographer, and the author has travelled widely in the study of his "obsession," as he himself terms it. In addition to chapters on biology, the book contains accounts of the fulmar in Iceland, Faeroe, Norway and St. Kilda, and four chapters on the spread of the fulmar in Britain, which is perhaps the main topic of the work.

The monograph, which is illustrated by excellent and sometimes beautiful photographs, runs to nearly 500 pages and is written in a clear and engaging style, not always characteristic of such productions. The author carries his learning lightly and the book can be opened at any page and read with pleasure and enlightenment. There are in addition eight short appendixes including one on the scientific names of the fulmars, and a final one on the palatability of the fulmar and its egg! There is also a short list of the more important references, as the full bibliography, which lists 2204 separate publications, was considered too lengthy for inclusion in a book intended for the general reader as well as for the specialist.

In A THOUSAND GEESE by Peter Scott and James Fisher (*Collins*, 1953, 21*s*) we have a readable and lively account of an expedition made in 1951 to central Iceland to find one of the main breeding grounds of the pink-footed goose. The

book does not however concern itself only with geese: Mr. Scott and his companions seem to be naturalists in the best of the older tradition, and all forms of plant and animal life were observed and collected as far as possible. The notes on the volcanic phenomena of the island, and on the shrinking icecap, whose streams and marshes form the background of the story, are of particular interest to geographers. The success of the expedition was crowned by the rediscovery of the ancient art of catching geese, the expedition employing nets and stakes in the same manner as the more permanent stone structures had been used by the earlier inhabitants, whose ruined goose folds had at first been such a puzzle to the party.

The book is presented mainly in the form of extracts from the diaries of Mr. Scott and Mr. Fisher, which give the reader a pleasant and sometimes almost embarrassingly intimate feeling of being part of the expedition. The text is charmingly illustrated with appropriate sketches by Mr. Scott, and by first rate photographs, taken by all the members of the expedition. The maps are very clear and helpful. The appendixes, including an account of the pinkfoot in Spitsbergen and Greenland and floral and faunal lists, provide a helpful summary of the work done by this and other expeditions, and round off the account in an admirable fashion. A. C. T.

HUMAN AND HISTORICAL GEOGRAPHY

THE SOUTH AFRICAN WAY OF LIFE. Edited by G. H. CALPIN and THE AUSTRALIAN WAY OF LIFE. Edited by G. CAIGER. Way of Life Series. *London: Heinemann*, 1953. 9×6 *inches;* 200 and 158 *pages respectively; illustrations.* 12*s* 6*d* each

These two books, each admirable in its way, have naturally a certain amount in common. In the first place, though both consist of a series of essays, each essay is written by a specialist in his field. Each specialist, too, is writing from the inside of affairs in his own country, with the aim of showing us how the man on the spot assesses the characteristics and the peculiarities of his contemporary home environment. This inside view does not however mean the narrow provincialism of the workman who knows nothing else than his own environment: with hardly an exception the authors have first-hand experience of universities or of affairs in Europe or America as well as at home, and many of them use effectively a comparative method to touch up the special properties of their own world. Each volume too by skilful editing gives the effect of developing a theme rather than of presenting a disjointed succession of discrete short stories, a rare enough achievement in works of this kind to merit acknowledgement. But there the resemblances end, and necessarily so. 'The South African Way of Life' is the ". . . study of a multi-racial society . . . representing at least four nations." 'The Australian Way of Life' is the study of as tightly homogeneous a British society as can be found anywhere in the world. As noted in the foreword, the theme of 'The South African Way of Life' is summed up by Marquard: "For the past 150 years the history of South Africa has been a history of struggle and conflict. Conflict between black man and black man, between white man and black man, between white man and white man; struggle of white and black man against a not over-generous nature—this is the background of its present problems." "Struggle against a not over-generous nature" has been far from unknown in Australia, but is implicit rather than explicit in this study, while the other forms of struggle that have given substance to the South African life of today have been virtually absent. Much therefore of the South African study is occupied by chapters on such topics as

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"The Afrikaans-speaking Section," "The English-speaking Section," "The South African Jewish Community," "The Bantu Peoples" while in the rest of the work, devoted to such topics as political institutions, education and economic factors, the stresses amongst these sections of the population condition the whole of the treatment.

In contrast, the chapter headings of the Australian book are "The Australian Nation," "The Family," "The Educational System," "Political Institutions and Aspirations," "Economic Institutions and Aspirations" and so on. Every page demonstrates the unity and uniformity of the nation and the very minor nature of the differences that exist either among different sections of the people or different parts of the continent.

Both books can be thoroughly recommended as sober, scholarly estimates of the character and trends of human life and institutions in the countries concerned, but maximum value will be got from either of them only by reading the other as well. R. O. B.

THE PATTERN OF HUMAN ACTIVITIES. By H. W. KING. *London: George G. Harrap (for the Australasian Publishing Company)*, 1953. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 646 pages; maps and diagrams.* 25*s*

This is the second edition of a book first published in Australia in 1946. It consists of a series of regional sample studies, chosen to show "the relation between man and his activities and his physical environment," and is intended for use in the upper forms of secondary schools and the first year of universities. This intention is probably mistaken as far as British schools are concerned, for neither the language nor the arrangement of the book are well suited to school use. But there is a great deal of interesting material that make it a very useful reference book for teachers of geography who are looking for a few detailed regional studies to give precision and depth to their teaching. Unfortunately, the regional examples are of a very uneven quality, some being so brief as be of little value; for example, the short chapter on "Primitive Subsistence Economies" deals with "The Amazon basin and the Amerinds," "Cold temperate Japan and the Ainus," and "The Arctic Lands and the Eskimos." Other examples however will be of more value to teachers. Not unnaturally, the Australian sections, such as "Canberra and the A.C.T.," "Industrial Australia," "Tropical Australia" and "Water conservation and irrigation in post-war Australia," are the most valuable parts of the book; but there are also useful sections on Indonesia and New Guinea. Many of the other examples are more fully dealt with in books quite easily available to teachers in this country.

The book lists are however detailed, the many descriptive quotations well chosen, and the appendix of up-to-date climatic statistics very useful, particularly the Australian ones. In brief, this is quite a valuable reference book for teachers of geography, but one could wish that the author had restricted himself to fewer and more detailed regional studies, perhaps on the lines of P. W. Bryan's 'Man's adaptation of Nature.' R. C. H.

THE TROPICAL WORLD: its social and economic conditions and its future status. By PIERRE GOUROU. Translated by E. D. Laborde. *London: Longmans, Green*, 1953. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xii + 156 *pages; maps and illustrations.* 18*s*

Since Professor Gourou's 'Les pays tropicaux: principes d'une géographie humaine et économique' was first published in 1947 there has been a remarkable increase in the interest shown in tropical regions, and its translation now makes available in English this excellent geographical background to the problems of

the tropics. Gourou has not attempted to cover all these problems but has judiciously concentrated on some of the outstanding features of tropical lands. Thus he begins, not with an outline of relief, climate and vegetation, but with a discussion of the generally low density of population in the tropics, noting however the important exception of the monsoon lands of Asia with teeming populations and a high degree of civilization. These facts lead naturally to a discussion of the unhealthiness of most tropical areas, the poverty of their soils and their characteristic agriculture.

The consequences, direct and indirect, of this agriculture are then noted, including the problems posed by population growth, the difficulties of stock-raising and of food supplies, and the need for agricultural improvement. "Education and hygiene," he writes, "are more important than methods or processes," and tropical Asia, he suggests, has pointed the way to the solution of some of the problems of Africa and Latin America. There follows an illuminating chapter on "hot, wet Asia," where the author is writing of those areas of which he has greatest personal knowledge.

So he brings us to the longest—and best—of the book's twelve chapters, where he discusses the problems resulting from European intervention, especially in the sparsely peopled, backward parts of the tropics. Much harm has been done to nature and to man, often unintentionally, through the spread of disease, the careless management of plantations, the introduction of certain European methods and the creation of excessive demands on man-power for transport purposes, as well as by the greed and violence sometimes shown by Europeans in their contacts with tropical peoples. Gourou suggests that this damage has resulted from European ignorance of the principle that "tropical conditions can only be commanded by being obeyed." Where European influence "has respected the demands of the geographical environment," its results have been beneficial, as shown in the struggle against disease and ill-health, in economic betterment and in improvements in agricultural technique.

In the final chapter Gourou summarizes many of the physical and other obstacles to the improvement of standards of living in the tropics, and emphasizes the urgent necessity of new methods of land use for those areas with rapidly growing populations. But his book is more than a guide to the geography of the tropics: it is a practical exposition of the nature of geography as widely understood today. It is to be hoped that the wider circulation of the book that will result from Dr. Laborde's skilful translation will bring home to many who are concerned with the tropics, but who are not geographers, the clear relevance of geography to the fuller understanding of the nature and problems of the lands and peoples of the tropics. R. W. S.

PIETRO'S PILGRIMAGE: A journey to India and back at the beginning of the seventeenth century. By WILFRID BLUNT. *London: James Barrie*, 1953. 8½ × 5½ *inches; 320 pages; map and illustrations.* 21*s*

Pietro della Valle's narrative of his journeys in the Middle East is known to students, particularly of Persian history, and he has been praised for his insatiable curiosity and his careful records. Originally written as letters to a friend, his book is long-winded and undiscriminating; according to Mr. Blunt, it is equal in length to ten modern novels. The Indian portion was translated into English in the seventeenth century, and this version was edited for the Hakluyt Society in 1892.

Mr. Blount introduces the "pilgrim," or "the Roman Ulysses of our age," as della Valle was popularly called, to the general reader in an entertaining work, which summarizes the original while concentrating on the incidents and

comments which throw light on the pilgrim's character, and on travel in the seventeenth century. Della Valle was absent from Italy for twelve years, and assiduously records all the "cose notabili" he encountered. He visited Constantinople and Egypt, where he conducted some amateurish excavations, and then crossed by the desert route to Baghdad. Most of his time was spent in Persia, whither he had been attracted by the fame of Shah Abbas. There he married a Nestorian Christian, who died five years later, and whose body he brought back to Italy. He was one of the earliest European writers to describe Persepolis and to draw attention to cuneiform inscriptions. At the limit of his journeying, he spent eighteen months at Goa, where he saw Portuguese grandeur in decline. Della Valle emerges as an inquiring and quite scholarly, but self-satisfied and pompous, traveller, who made the most of his opportunities and was not deflected from his purpose by the prospect of danger or hardship.

G. R. C.

GENERAL

ALPINISMO ITALIANO NEL MONDO. Compiled by the Scientific Committee of the Italian Alpine Club. *Milan: Club Alpino Italiano: Touring Club Italiano*, 1953. 10½×7½ *inches; 353 pages; maps and plates*

This handsome volume edited by the Scientific Committee of the Italian Alpine Club was planned to meet the frequent enquiries from members about the possibilities for climbing outside Europe, particularly in areas where Italians had already been active. This demand grows rapidly now that the Alps offer few fresh objectives apart from "excentric" feats. Professor Desio makes some general remarks on the opportunities outside Europe offered by modern communications and on the problems of logistics involved. Each continent is then considered in turn; after a general survey, the work of Italian mountaineers is briefly described, in many cases by the climbers themselves. The Caucasus, the Himalaya and Karakoram, and South America have been the main scenes. Though familiar names such as the Duke of the Abruzzi, the Duke of Spoleto, Vittorio Sella, F. de Filippi and A. Desio naturally recur, their achievements are not described in too great detail, so that the records of lesser known alpinists can be included. The part played by Italian guides is not overlooked. The text is generally accurate, and is adequately documented. The numerous excellent illustrations themselves make up an attractive album of mountain scenery.

G. R. C.

RECENT TRAVEL BOOKS

Four recent books, all of social-anthropological interest, have for subject, in their different ways, the impact made on Western minds by cultures of the mysterious and varied East.

Despite contacts with France, through the Arabic language and Islamic religion Morocco may be said to belong to the East. Being specially attracted to this Islamic way of life, and having great sympathy for its followers, the writer Peter Mayne tried to live a "back-street life" among the people of Marrakesh. He made himself proficient in Arabic and tried to immerse himself in Mohammedan ways of thinking with their utterly different approach to all matters from plumbing to sexual morality. THE ALLEYS OF MARRAKESH (*John Murray*, 1953, 15*s*) is a study in depth of the Moorish way of living, the work of an individualist who scorns the conventional "tourist" approach, engagingly written, with delicacy and wit. The book leaves a distinctive and vivid impres-

sion. The few line drawings seem to give added authenticity to a delightful and memorable work.

Mrs. Sinclair Mehdevi is an American journalist who married a Persian and, after seven years, decided to visit her Mohammedan in-laws and bring her mental pictures of them to face reality. PERSIAN ADVENTURE (*Gollancz*, 1953, 13*s* 6*d*), the book that comes from her stay, is a readable, entertaining and intimate account of this life as seen through a woman's eyes. At first the sheltered, narrow existence of her Persian equals seems almost unbearable, but then with a young relative she manages to get out a little—for instance, to see Teheran's famous peacock theatre. Eventually gaining favour with her redoubtable father-in-law, Hajj Malek, former owner of large estates, she goes off with her husband to visit a remarkable expatriate Viennese doctor at Shaft in Gilan, on the coast of the Caspian. 'Persian adventure' contains a great many asides on Persian habits, and such things as the meaning of *taroof*—polite behaviour according to long established customs. From seeing the world from behind a *chador*, the all-enveloping female garment, Mrs. Mehdevi ends describing her own marriage ceremony according to Islamic rites.

The society of the third book here considered is a primitive one, the Temiar group of Senoi aborigines of the Malayan jungle. Tom Stacey, a promising young writer, decided to spend a fortnight's leave from the army as far from white men in Malaya as he could go, and this book is the diary he kept while with the shy and increasingly rare native dwellers in Kelantan state in Northeast Malaya. With a very good introduction on the present state of this troubled country, THE HOSTILE SUN (*Gerald Duckworth*, 1953, 15*s*), occasionally hasty and even naïve, makes a strong appeal by its patent sincerity. The "wide-eyed twenty-year-old" who is so anxious to inspire trust and finds himself strangely implicated in primitive fire ritual can hardly fail to find sympathetic readers among his own countrymen. Though Mr. Stacey lost most of his own photographs, the book is well illustrated.

Olle Strandberg, in TIGERLAND AND SOUTH SEA (*Michael Joseph*, 1953, 18*s*), is no "wide-eyed" youngster, but an eminent Swedish journalist for whom there are few illusions. His book is the outcome of two years' travels in India, China and Siam followed by a rather vain search for paradise among the islands of the South Sea. Fundamentally, it seems that the principles behind Mr. Strandberg's journey are much the same as those behind Mr. Stacey's. Both men are seeking the genuine, the unspoiled. The power behind Olle Strandberg's writing makes his book outstanding. His pictures of the leavetaking of the maharajahs and of sorrowing Mother India are followed by brilliant pieces on the land "behind the bamboo curtain" and on unbelievably repulsive oriental dishes. Buddhistic Siam finds favour before the disabused traveller passes on to the over-commercialized Honolulu. He finds Tahiti over-rated with bathing beauties suffering from dental decay, but paints a striking picture of suffering and bravery among the lepers of Molokai. Other Hawaiian islands are haunted by scenes of brutality and this book ends, a trifle lamely, with talk of reasonable cannibals.

L. R. W.

THE SOCIETY'S NEWS

MEDALS AND AWARDS, 1954

Her Majesty The Queen has been pleased to approve the award of the Royal Medals as follows: *The Founder's Medal* to Brigadier Sir John Hunt, C.B.E., D.S.O., leader of the British Mount Everest Expedition; *The Patron's Medal* to Dr. N. A. Mackintosh, Deputy Director of the National Institute of Oceanography, for research and exploration in the Southern Ocean since 1924, with special reference to his voyages in *Discovery II*, 1929–31 and 1933–35. The Council have made no award this year of the *Victoria Medal*; *The Murchison Grant* has been made to G. R. Crone, Librarian and Map Curator of the Society, for contributions to the history of cartography and to the history of geography; *The Back Grant* to Commander G. S. Ritchie, D.S.O., R.N., Hydrographic Department of the Admiralty, for his contribution to oceanographical exploration as Commanding Officer of H.M.S. *Challenger*, 1950–51; *The Cuthbert Peek Grant* to Dr. T. E. Armstrong, Scott Polar Research Institute, for studies in the history and economic development of the Arctic, with special reference to the Northern Sea Route; *The Gill Memorial* has been awarded to Dr. W. G. V. Balchin, recently appointed Professor of Geography at the University College of Swansea, for contributions to geomorphological and geographical research; and *The Mrs. Patrick Ness Award* goes to C. W. M. Swithinbank, its first recipient, a member of the Norwegian–British–Swedish Antarctic Expedition 1949–52, for research in Antarctic glaciology.

THE AFTERMATH OF EVEREST

As soon as the news of the successful ascent of Everest had been received by the Himalayan Committee of the Society and the Alpine Club, it was realized that a massive task of organization and coordination would be inevitable, if the story of the Expedition was to be presented fully and in the most appropriate way, through the various media available. Books, lectures, films, radio and television all had to be considered, and the following brief summary of the various post-Everest activities will show the extent of the undertaking.

The Expedition arrived in this country early in July, but by August a lecture tour was in full swing by Sir Edmund Hillary and Mr. W. G. Lowe in New Zealand. For Brigadier Sir John Hunt, the leader of the Expedition, August was devoted to writing 'The ascent of Everest,' which has since become a best seller in most of the countries in which it has appeared.

As soon as the team were reunited at the Society in London early in September, the full lecture programme was launched, starting with a series under the auspices of the Society and of the Alpine Club (as already described in the *Geographical Journal* for December 1953), and followed by tours abroad. The first major Continental lecture was delivered in Paris by Brigadier Sir John Hunt, Mr. Alfred Gregory and Sir Edmund Hillary, and was given throughout in French. It was attended by the President of the French Republic and the British Ambassador in Paris. This lecture, which was repeated, was followed by a number of similar meetings in the capital cities of the Low Countries, after which Sir Edmund Hillary made a tour of Scandinavia, including Finland. In the meanwhile, Major C. G. Wylie, outward bound for Malaya on return to duty, broke his journey for a very successful lecture tour in Jugoslavia.

Foremost in importance among the public engagements on the Continent were of course those undertaken in Switzerland, a country which had played such a great part in preparing the way for final victory. Unfortunately Brigadier

Sir John Hunt was prevented by ill health from visiting Switzerland, neither was Sir Edmund Hillary able to go, as had been hoped; in their place the lectures were given by Mr. Wilfred Noyce, speaking both in French and in German. Until the end of the year, these Continental meetings were interwoven with a heavy programme of lecturing in the main cities of the British Isles, together with a number of special addresses by members of the Expedition to organizations, groups and clubs concerned with some aspect of exploration or climbing.

The chief event of the New Year was the formidable lecture tour planned for the United States and Canada, which opened in New York City on January 29. In all twenty-eight lectures were given, culminating in one in Honolulu on March 14. In the six weeks available only a selected number of the major cities in the United States and in Canada were able to hear the Everest story and requests for a further tour were frequently received by the lecturers, Sir Edmund Hillary, Mr. Charles Evans and Mr. W. G. Lowe. Throughout their tour across North America, the lecture team was accompanied by Mr. James Morris, who had been *The Times* Special Correspondent on the Expedition, and by Lady Hillary.

The achievement of the British Mount Everest Expedition received notable acknowledgement in the United States, in the award to the team as a whole of both the Hubbard Medal of the National Geographic Society and the American Geographical Society's Cullum Medal—this latter being the oldest geographical award in the Western Hemisphere, instituted in 1896 when its first recipient was Admiral Peary. At the White House on February 11, President Eisenhower presented the Hubbard Medal to Sir John Hunt who, with Lady Hunt, had flown over from England to receive it on behalf of his team. The British and New Zealand Ambassadors were present at the ceremony, and Sir John was also given replicas of the medal for Sir Edmund Hillary and Sherpa Tenzing. The Cullum Medal was received by Dr. Charles Evans, deputy leader of the Expedition, on March 18, also on behalf of the team. The Director of the American Geographical Society, Mr. Charles B. Hitchcock, presented Dr. Evans with two identical gold medals, one to be given into the custody of the Joint Himalayan Committee of the Royal Geographical Society and the Alpine Club, and one to be deposited at Thyangboche Monastery as a tribute to the Sherpa porters who joined in the successful ascent of Everest. Neither the Hubbard (founded in 1906) nor Cullum medals have been awarded before to a group rather than to an individual.

No account of the American tour would be complete without some reference to the arduous work put in on behalf of the British sponsors by the volunteer American Everest Committee, which was set up at the instigation of Sir Edwin Herbert, in New York, under the Chairmanship of Mr. Elliott B. Macrae, President of E. P. Dutton and Company, the American publishers of 'The ascent of Everest.' This Committee was primarily responsible for the organization and coordination of publicity and social engagements in cooperation with the Committee's lecture agent, Mr. Ford Hicks of Chicago. Including representatives of both the American Geographical Society and the American Alpine Club, it was in an excellent position to ensure that the story of Everest was presented in the right way throughout America, and it is certainly true that the considerable success which the lecture tour enjoyed was due substantially to the efforts of the American Everest Committee.

While the team were hard at work in North America, not only with a full lecture programme, but also with a heavy burden of radio, T.V. performances and innumerable social engagements, further lectures were being given on the

Continent of Europe by Mr. Wilfred Noyce in Germany, Italy and Greece, and by Mr. Alfred Gregory in France, Belgium and French North Africa. At the moment, lectures are being planned for as far ahead as October and November, and tours to North America, to Australia, to Japan and to South Africa are all possibilities for the future.

It was thought at first that the simultaneous showing of the Everest film 'Conquest of Everest' might be a threat to the success of the Everest lectures in the same countries. This however proved as a general rule not to be the case; the film and lectures were found to supplement each other. The film had the distinction of being chosen as one of the ten best films for 1953 in the United States and generally has had a remarkable success, all the more remarkable since a full-length documentary film shown as the main feature is a comparative innovation. There is no doubt that, with the accounts of the lectures and with the various books, the film will be one of the famous documentaries of exploration for a long time to come.

GRANTS TO EXPEDITIONS 1954

The Council has approved grants totalling £580 to eight expeditions in 1954. The Oxford University Exploration Club receives £125 towards an expedition led by Mr. H. J. Harrington [1] to the headwaters of the Karnali River, West Nepal, and £125 for the party led by E. P. Battey-Pratt,[1] which will study land utilization and geomorphology in Angola, Portuguese West Africa. A joint party from Birmingham University and University College, Exeter, is to study the stratigraphy and palaeontology of West Spitsbergen, and receives a grant of £100. Five applications from Cambridge undergraduates have been met. Two parties receive £50 each to study peasant economy; one led by D. Haworth to the vicinity of Lake Van, Turkey, which will also make a reconnaissance of the headwaters system of the Tigris and Euphrates; the second, led by R. D. Hayes, to Northern Portugal. D. M. Metcalfe and C. P. Burnham, studying land use in north-west Jugoslavia, receive £30, and a party under P. J. Williams,[1] which will investigate solifluction and freeze thaw in northern Norway, £50. A group of three led by P. J. Murphy has been allotted a grant of £50 from the Penruddocke Bequest for African Exploration, for their proposed geographical and economic survey of the Plain of Tadla in French Morocco. The Council has also given its approval to Nottingham University Exploration Club for the continuation of last year's glaciological and geomorphological work in south-east Iceland, and has agreed to a loan of instruments to this party.

GEOGRAPHICAL ESSAY PRIZE

The Council has accepted the recommendation of the examiners that no award of the Geographical Essay prize be made this year. Six essays only were submitted, of which four greatly exceeded the stipulated length of five thousand words. The examiners considered that three were good studies at undergraduate level, but that for various reasons none qualified for the award. The limit on length has been fixed to encourage a larger entry, and the Council hopes that this will be achieved in 1955. A prize of £10 will be awarded for the best geographical essay *not exceeding* 5000 *words in length*, including sketch-maps and diagrams, written by a student reading geography at a university in Great Britain or Northern Ireland during the academic year in which the essay is submitted. The Council reserves the right to publish or to retain for the Library any of the essays received. Essays must reach the Director and Secretary by 15 January 1955.

[1] These grants include a subsidy from the Stephens Bequest for botanical geography.

THE RECORD

CONTRIBUTORS TO THIS ISSUE OF THE *JOURNAL*

Douglas Busk, British Ambassador to Ethiopia, has climbed extensively in many parts of the world. *Heinrich Harrer*, who escaped from internment in India in 1944, and spent seven years in Tibet, was well known as a climber before the war, in particular for his ascent of the north face of the Eiger. *Dr. W. G. V. Balchin*, this year's recipient of the Gill Memorial, and Lecturer in Geography at University of London, King's College, has recently been appointed to the newly established Chair of Geography at the University College of Swansea; *Norman Pye* is Lecturer in Geography in the Victoria University of Manchester. *K. M. Barbour*, who is studying peasant agriculture and rural economics in the Sudan, has been Lecturer in Geography at University College, Khartoum, since 1948. *Dr. Griffith Pugh* is a physiologist working for the Medical Research Council whose attachment to the Cho Oyu (1952) and Mount Everest (1953) expeditions was made possible by grants from the Royal Society. *J. J. Holtzscherer* of the Expéditions Polaires Françaises was in Greenland during 1949, 1950 and 1951; *G. de Q. Robin* accompanied the Norwegian–British–Swedish Antarctic Expedition, as a physicist, to Dronning Maud Land where he worked from 1949 to 1952, and he is on the staff of the University of Birmingham. *R. L. Cloet* is an officer in the Hydrographic Department of the Admiralty. *Professor R. Miller* is Professor of Geography in Glasgow University where *R. Common* is a Lecturer; *R. Galloway* is a research student at Edinburgh University.

UNIVERSITY NEWS

SCHOLARSHIPS IN GEOGRAPHY AT CAMBRIDGE

Clare, Downing, Jesus and Trinity Colleges are, for the first time, offering awards in Geography in the December 1954 Scholarship Examination. There will be one paper in Physical Geography and two in Human Geography. Candidates will also be required to take one of the following three alternatives: (*a*) *either* Biology *or* Geology (in each case including the practical examination) as set to candidates in Natural Sciences; (*b*) a paper in Pure Mathematics and a paper in Applied Mathematics; (*c*) two papers chosen from among papers 2 (General Historical questions, including Economic History), 3 (English History) and 6 (European History after 1492 and American History) set to candidates in History. There will be the usual English Essay, the paper on General Questions, and the Translation paper giving two passages in each of a number of modern and ancient languages in which candidates must show a moderate proficiency in one language or some lesser knowledge of two languages.

Girton, Newnham, St. Catharine's and Selwyn Colleges have for many years offered Scholarships in Geography in their February–March Examination and St. John's College has more recently offered such awards in their December Examination. It is therefore possible, provided candidates of sufficient merit present themselves, for about fifteen awards in geography to be made at Cambridge each year. Applications should be forwarded to the Senior Tutor of the college of the candidate's preference. W. V. L.

TWO NEW CHAIRS OF GEOGRAPHY

Appointments have recently been announced to two new Chairs of Geography. Mr. F. J. Monkhouse, Lecturer in Geography in the University of

Liverpool, has been appointed Professor of Geography in the University of Southampton and Mr. W. V. G. Balchin, Lecturer in Geography in the University of London, King's College, to the Chair at University College, Swansea.

UNIVERSITY OF NATAL

The University of Natal is a dual institution; at Pietermaritzburg, the provincial capital, and at Durban, the largest city. In Durban there is a further division between European and non-European work. The Department of Geography operates in both centres.

The main section in Pietermaritzburg, which is concerned with full-time European students, is under the charge of Professor R. M. Jehu, M.SC.(Wales), assisted by Mr. O. Williams, M.A.(Wales), and Mrs. E. Wakeman, B.SC. (S.A.). Courses are offered leading to the ordinary and honours degrees in Geography, together with the University Diploma in Education. There are several post-graduate students reading for the degrees of M.A. and PH.D. of the University. In all, some 85 students were reading Geography in 1953.

In Durban the main work of the department is at present confined to the non-European section, housed separately from the main body of the University. In 1953 there were 40 students, mainly Indian but with some coloured and African students, reading for the ordinary and honours degrees. Ancillary courses in Economic Geography are also offered to full and part-time European students, about 35 in number, and in 1954 a first-year degree course in Geography is to be offered for European students. H. C. Brookfield, B.A., PH.D. (Lond.) is the lecturer-in-charge, and has been assisted in 1953 by J. McI. Daniel, B.A. (Natal).

The department has been active in research despite the heavy load of teaching imposed on its small staff. Professor Jehu is engaged upon Regional Planning work in association with the Natural Resources Development Council and the Natal Provincial Administration; Mr. Williams has worked on certain aspects of the economic geography of the Transvaal and is now studying the distribution and characteristics of industry in Natal in relation to local resources; Dr. Brookfield has been engaged in port studies in south and east Africa, and is studying also the political geography of eastern Africa and the western Indian Ocean, with particular regard at present to the Indian emigrant communities; Mr. Daniel has recently completed a study of the agricultural geography of the Pietermaritzburg district, and a former lecturer, Dr. T. J. D. Fair, has completed a study of the distribution of population in Natal, and is engaged on geomorphological research in cooperation with Professor L. C. King of the Department of Geology, University of Natal. Research excursions, sometimes in cooperation with other departments, have been made during 1953 in many parts of Natal, Zululand and Swaziland, and it is hoped that this aspect of the work of the department may be considerably extended in the near future.

The department is still in the process of building: it is in need of more students of good quality, of greater facilities for research, and of more staff. A beginning is being made in remedying this latter defect. Geography has been a neglected subject in South African education, but an appreciation of its value is perhaps shown in the appointment of Dr. Fair to a senior research post in the Natural Resources Development Council, in 1952. Africa offers an enormous field for research, and the geographer has a large contribution to make in studying its problems. Unfortunately, most geography staffs in South Africa are too small, and consequently too overburdened and unspecialized, to make the effective contribution of which they are capable.

H. C. B.
O. W.

UNIVERSITY OF NEW ZEALAND (AUCKLAND UNIVERSITY COLLEGE). A SAMOAN SURVEY

The Department of Geography at Auckland University College (University of New Zealand) has recently received a grant from the Carnegie Social Science Research Grant Committee for the purpose of appraising the nature and extent of the resources of Samoa, with special reference to problems resulting from the demands made upon these resources by a population rapidly increasing in number and advancing in political status. This project will take at least five years to complete and is thought to be the first of its kind ever to be undertaken by geographers in the Pacific.

The project will involve, among other things, a geographical field survey of the resources, population, economy and contemporary land use practices both indigenous and introduced. A detailed investigation will be made of some of the more serious problems such as the implications of rapid population growth, land and land tenure problems, inadequacy of transport, problems of commercial agriculture undertaken in tropical conditions and other social, economic and political problems arising from the transition from traditional subsistence to a modern commercial economy. An attempt will be made to find solutions for these problems and to make proposals for the most efficient long-term use and conservation of Samoan resources.

The Auckland University College Department of Geography Samoan Survey, as the research organization will be called, will be directed by Professor Kenneth B. Cumberland, M.A. (London), D.SC., who is already well known for his interest in Pacific affairs. Members of the Survey have a variety of formal qualifications. Special interests include land use, geography of resources, economic implications of climate and physical geography. The present staff of AUCDGSS other than the Director will be James W. Fox, B.A. (Lond.), Leslie Curry, B.A. (Dunelm), M.A. (Johns Hopkins), Bryan H. Farrell, B.A. (N.Z.), M.A. (Washington) and William J. Brockie, M.A. (Edin.).

The research programme was planned to begin in December 1953 when a preliminary survey of the physical geography of the islands will be undertaken. In the summer of 1954 a concerted effort will be made to carry out detailed mapping and interpretation and for this work it is expected that four members of the Survey will be in Samoa. B. H. F.

RESEARCH EXPEDITIONS TO ICELAND

As a result of the tragic disasters which have befallen research parties in Iceland, the National Research Council has issued from Reykjavik a warning to those who prepare such expeditions.

It is pointed out that the wastelands of Iceland cover large areas and are very dangerous for travellers, especially those who are not familiar with the country. The Research Council urges that leaders of foreign parties should take care to familiarize themselves with local conditions and to make all plans in consultation with persons who know the terrain.

In future, permits for scientific research will not be granted as a rule to those who intend to travel alone in the wastelands, and in distant districts it is considered risky to travel even in pairs.

Universities and other research institutions who intend to send students to Iceland should consult the National Research Council in good time concerning a suitable field of study. Preferably, such expeditions should be made under the supervision of Icelandic specialists who will endeavour to coordinate the work of the various groups. Difficult research work will only be entrusted to skilled scientists who are familiar with local conditions. But such scientists should also work in close cooperation with Icelandic scientists or institutions engaged in similar work.

CONVERSION TABLES FOR GEOGRAPHERS

At the 17th International Geographical Congress, held at Washington in August 1952, a Special Committee on Conversion Tables was appointed, consisting of Dr. H. K. Amiram (Israel), chairman, Frank George (Great Britain) and O. M. Miller (U.S.A.). Proposals for a comprehensive volume of tables have now been drafted by Mr. Miller, and are printed in IGU, the Bulletin of the International Geographical Union, for December 1953. Dr. H. K. Amiram, The Hebrew University, Jerusalem, Israel, invites geographers to submit comments on the proposals (in duplicate if possible) not later than 21 July 1954. The Royal Society holds a small stock of the Bulletin in which the proposed tables are set out for study by those interested.

GEOGRAPHERS IN THE GOLD COAST COLONY

Geography is well represented in the Department of Soil and Land Use Survey in the Gold Coast Colony. Out of a staff of eighteen senior officers, there are four geographers from Cambridge, two from Aberdeen and one each from Oxford, Durham and Edinburgh. A post for a senior geographer was in January still unfilled. Under the Gold Coast's second five-year plan, it is likely that there will be further vacancies for graduates in geography. The possibility is also being considered of recruiting for short tours of twenty-four months one or two members of university geographical departments, physical geographers, who would be seconded for special investigations. The Director of Soil and Land Use Survey in the colony is Mr. C. F. Charter, and his headquarters are at Kumasi.

NOTE ON THE HEIGHT OF MOUNT KENYA

As a result of trigonometrical surveys made by the Directorate of Colonial Surveys in the Mount Kenya area, new height values, believed to be more accurate than those accepted at present, have been obtained for the principal peaks of the mountain.

The method adopted for obtaining these heights was as follows: a ring of coordinated points was established on the high moorland zone surrounding the peaks, these points being variously fixed by fully observed triangles, resections and intersections from existing Local Survey Department triangulation stations in the plain around the mountain. Vertical angles (generally reciprocal) were also observed.

From the moorland stations, intersecting rays were then observed to the highest peaks. The danger of observing false summits was minimized by the different aspects seen from the various points, and by the sharp nature of the peaks themselves. Check rays were also observed from the more distant stations, though these were not used in evaluating the mean. A refraction coefficient of 0·07 was assumed, any error caused by variations in this being very small in view of the shortness of the lines involved.

Kenya datum was accepted throughout, and although the Local Survey Department trigonometrical points around the mountain were from two unconnected schemes, a close measure of agreement was obtained.

The final results were as follows:

Station	*Mean height above sea level (feet)*	*Number of rays*	*Range (feet)*
Batian (Highest point of Mt. Kenya)	17,058	8	10·8
Nelion	17,022	6	10·9
Lenana	16,355	4	11·3

The previously accepted height for Batian was 17,040 feet (vide 1 : 1,000,000 Mombasa–Nairobi E.A.F. No. 1316, 1 : 500,000 G.S.G.S. 4355 Sheet SA–37/1 Second Edition, 1 : 250,000 G.S.G.S. 1764 Sheet SA–37/B) or 5194 metres (vide 1 : 2,000,000 North A36–37/South A36–37).

SOME CARTOGRAPHICAL PUBLICATIONS

Several interesting new atlases, or instalments thereof, have recently been received in the Society's Map Room. Mr. Herbert Bayer has presented a copy of the 'World Geographic Atlas,' edited by him and privately printed for the Container Corporation of America at Chicago, 1953. This is described as "a composite of man's environment." In general, each topographic map is accompanied by a page of sketch-maps, cartograms and drawings, which convey a good summary idea of the history, physical geography, land use and production of the area. There are three main sections, an introduction with world maps on Goode's homolosine equal area projection; the United States, with maps mostly on a scale larger than 1/3M., a section printed by Rand McNally; and the rest of the world on scales from 1/10M. and larger, with relief by layer colouring and hatching. This section is the work of the Istituto Geografico De Agostini, Novara. Much thought has clearly been given to the design and compilation, and the result is an attractive and well-printed atlas, with many novel features.

As an example of a special atlas, the volume of the 'Deutscher Planungsatlas' dealing with Niedersachsen is worthy of notice. This has been edited by Dr. Kurt Brüning of Göttingen, Director of the Niedersachisen Amt für Landesplanning, Hannover. In a series of more than 170 plates, the physical geography, agriculture, industry, population and history are dealt with in great detail, many of the distribution maps being on a *gemeinde* basis. Of interest are the maps dealing with the influx of refugees; in a number of communes the newcomers outnumber the old residents by two to one. There can be few regional atlases to rival this in comprehensiveness.

In course of publication are three "national" atlases, for Sweden, Australia and Belgium. The 'Atlas över Sverige,' edited by Svenska Sällskapet för Anthropologi och Geografi, maps the country in two halves on facing pages, which allows a scale of 1/2M. The complete atlas is to contain 150 sheets, which will include cultural and historical maps. The maps are excellently printed in colour, and each is accompanied by an explanatory text with statistical tables and diagrams, and a summary in English.

The preliminary contents list of the 'Atlas of Australian Resources,' prepared by the Department of National Development, Canberra, mentions 42 sheets, each of which is to be accompanied by a brief commentary. The principal distribution maps are on a scale 1/6M.; they are well printed in colour and show considerable detail. The climatic information is attractively set out with one double page devoted to each factor, arranged with maps of the twelve monthly means in a circle surrounding that of the annual mean. The corners are filled in with explanatory notes and maps of extremes or other interesting but less usual aspects.

The 'Atlas de Belgique' edited by the Comité National de Géographie, Brussels, also in course of publication, is another well thought out and carefully produced work. The principal maps, each covering a double page, are on a scale of 1 : 500,000 and include such subjects as Morphology and Regional Divisions which combine geographical interpretation with the statement of facts. The complete atlas is to contain 52 sheets and descriptive text for each is also to be prepared.

Mention may also be made of the 'World Forestry Atlas,' which began publication in 1951. This is edited by Dr. F. Heske and Dr. E. Otremba, and published by the Bundesanstalt für Forst- und Holzwirtschaft, Hamburg. The majority of the maps so far issued merely show the general distribution of forests by solid green on outline maps, but there are a map of the distribution of species in the Ukraine and vegetation maps of New Zealand for 1840 and 1940. Only in a few instances are authorities quoted.

A publication with the title 'Beiträge aus der Sovietischen Kartographie' arouses expectations, which are not however fulfilled. These papers, translated from the Russian, include a lengthy discussion by a number of cartographers on the problems of detail versus legibility in map compilation, and of generalization. The argument is heated, and existing maps are criticized or defended; but without examples to judge by it is difficult to form an opinion. The unexceptional conclusion appears to be that the content of the map will vary according to the character of the area and the purpose of the map. The other essays are mainly concerned with the history of Russian cartography and Russian school atlases.

A useful guide to available maps of much of Africa—'Maps of Africa south of the Sahara'—has been published by the Scientific Council for Africa south of the Sahara. This is based on a provisional list compiled by Dr. Harrison Church, but extensively enlarged by information from official departments. The maps are listed by political headings, topographical maps first, followed by town plans, and then special maps classified by subject. A useful feature is the inclusion of maps published in bulletins and scientific periodicals. Copies may be obtained from Dr. Harrison Church, London School of Economics, price 3*s* post free. A leaflet giving similar information for the Caribbean, compiled by Dr. Harrison Church and Miss Ursula Rodd, may also be obtained from him, for 4*d*.

The extent to which air photographs can supplement the topographical map in the detailed geomorphological analysis of an area is discussed at length by K. Stübner in 'Das Luftbild im Dienste geomorphologischer Feinanalyse,' a publication of the Geographical Institute of the Friedrich Schiller University, Jena. Dr. Stübner is mainly concerned with soil erosion, and records the results of his work on the Ilm limestone plateau. G. R. C., A. M. F.

Sweden's contribution to the cartographic enterprise of Europe is all too little known. The grand publications of the baroque age and the detailed work of the eighteenth century land measurers are traditions continued in the twentieth century. The new 'Atlas of Sweden' is mentioned above. Meanwhile, for some years, W. William-Olsson, Professor of Economic Geography in Stockholm's Handelshögskolan, has been experimenting with the cartographical representation of Sweden's industrial and agricultural activity. A bird's-eye view of the essentials was published in his 'Ekonomisk-geografisk karta över Sverige,' scale 1 : 1,000,000, 1946. An accompanying text appeared in Swedish the same year.

Professor William-Olsson has now extended his method to Europe (including Russia in Europe) and the resulting economic map, scale 1 : 3,250,000, is published in an English edition (Geographia Ltd., 1952) both as a wall map (in two sheets) and in atlas form (in twenty sheets). A text, which is a model of brevity, also accompanies the map. The text deals with the projection, the scale and generalization, the system of signs—including its merits and defects, and the source material. Some fifteen European collaborators have aided the author—in Great Britain, Professors Stamp and Beaver and Dr. Fleming.

Two primary features are shown by the map: first, the distribution of all towns with more than 10,000 inhabitants—by a system of spheres proportional in size to the towns and coloured according to their dominant occupation; secondly, the distribution of cultivated land—by white squares each representing 100 square kilometres against a grey background. Insets of the north-west European and northern English industrial areas highlight the method of using coloured spheres to represent industrial agglomerations. In a continent too frequently treated by geographers on a country by country basis, the map is a welcome attempt to see Europe as a whole. The common denominator of the spheres and an equal area projection, which provides the absolute as well as relative distribution of cultivated area, offer a new comparative appreciation of Europe's economy. The map is valuable both as a complement to the standard physical map of Europe and as an exercise in methodology for discussion in cartography classes. W. R. M.

RUSSIAN PERIODICALS IN THE SOCIETY'S LIBRARY

Two important geographical periodicals published in the Soviet Union today are the *Izvestia (Bulletin) of the Academy of Sciences of the Soviet Union (Geographical Series)* and the *Izvestia of the All-Union Geographical Society*. The following list of the main papers contained in these periodicals is intended to indicate some of the more important problems occupying geographers in the Soviet Union. The Library of the Society owns almost complete sets of both these periodicals which are received from time to time from the Academy of Sciences in Moscow and from the All-Union Geographical Society's headquarters in Leningrad. The main papers contained in these two Bulletins during the first part of 1953 are listed below. The list for 1953 will be completed in the September *Journal*.

Bulletin (Izvestia) of the Academy of sciences of the U.S.S.R.: Geographical series for 1953. No. 1. Problem of the consequences of the approaching fall in level of the Aral sea: by C. Y. Geller and R. A. Sorokina. Some principles of the formation and diffusion of snow-drifts, and the principles of organizing methods of dealing with them: by G. D. Richter. Ancient shorelines on the sea bed: by A. P. Lisitsyn and G. B. Udintsev. The paleogeography of natural zones of the European area of the U.S.S.R. in the Post-glacial period: by M. I. Neishtadt. The natural and economic conditions of the development of horticulture in the Issyk-Kul'sk basin, and the possibilities of transforming it into an important fundamental part of the fertile zone of Central Asia: by O. A. Vorontsova and S. N. Ryazantsev. The contribution of Russian scientists and cultural workers in geographical study of the countries of the East (Japan, South-east Asia and India): by K. M. Popov. Plan for a canal between the rivers Gzhdat and Vorya, in the first part of the 18th century: by K. I. Shafranovskii.

No. 2. Changes in spring and low-water flow of large river plains in the European part of the U.S.S.R., in connection with the transformation of natural conditions in their area: by S. L. Vendrov. Characteristics of drought periods with reference to the general circulation of the atmosphere: by V. M. Kurganskaya. Lithographic peculiarities of alluvial valleys in dry climatic conditions: by A. I. Popov. New data concerning the vegetation of the Russian plain in Late and Post-glacial periods: by G. N. Lisitzina. The transformation of nature in the Latvian S.S.R.: by M. I. Rostovtsev and V. R. Purin.

No. 3. Geographical conditions for the improvement of agricultural land utilization in the non-black earth areas of the European part of the U.S.S.R.: by A. A. Grigoriev. The reciprocal climatological action of irrigated and

non-irrigated areas: by A. P. Galtsov. Some theories from new investigations in the Uzboi region (Turkestan S.S.R.) in paleogeography and geomorphology: by A. A. Yamnov and V. N. Kunin. Natural conditions and how to further the development of the agricultural economy of Kulunda (W. Altai): by M. I. Pumus.

Bulletin (Izvestia) of the All-union Geographical society Moscow–Leningrad for 1953: vol. 85. No. 1. Bush undergrowth as a type of vegetation: by B. A. Bykov and E. F. Stepanova. Has the climate of the Ukraine altered since ancient times?: by I. E. Buchinskii. "Ptolemy's map" in the light of historical geography of the Caspian area: by S. A. Kovalevskii. Influence of woodland on the circulation of moisture in the atmosphere: by V. V. Rachmanov.

No. 2. General characteristics of the geographical distribution of forest vegetation in the west Siberian plain: by B. V. Sochava and others. The Baikal rype of quaternary glaciation: by V. V. Lamakin. Classification of subdivisions of the Pacific ocean: by A. M. Muromtsev. Political instructions in schools and the tasks of geographical education: by A. V. Darinskii. A star map engraved in Russia in the 18th century: by K. I. Shafranovskii. Forgotten discoveries by Russian sea-voyagers in the Marshall islands: by V. O. Guretskii.

No. 3. Tasks of botanical research connected with the directives of the Communist Party's 19th congress, in the 5th Five-year plan 1951–1955: by A. A. Korchagin. The first printed Russian plan of the Leningrad district: by K. I. Shafranovskii. The "Academy" plan of St. Petersburg, 1753: by G. A. Knyazev. Frozen gold in the Scythian tombs of the Pazyryk district in the upper Altai: by I. J. Baranov. Evidence of Karst in lower Western Podolia: by A. D. Kucherek. New facts concerning the maximum depths of the Pacific ocean: by D. B. Karelin. New changes in the administrative divisions of Roumania: by S. F. Burenko. Air survey in Canada: by S. V. Obruchev.

CORRECTION

It is regretted that an incorrect report was printed of Mr. A. T. Grove's remarks in the discussion which followed Mr. B. H. Farmer's paper on "Problems of land use in the Dry Zone of Ceylon" (*Geogr. J.* 120 (1954) 31). Mr. Grove has asked us to print the following correct version:

Mr. A. T. Grove: We have heard a lot in recent years about the possibility of developing the desert lands, the very dry areas of the world. We have just been shown some of the difficulties involved in agricultural development in areas where the rainfall is, by comparison, fairly high. In Ceylon, it is true, there is quite a lot of land which is not very productive; in Africa, particularly West Africa, and in other tropical countries, there are millions of acres whose potentialities can as yet hardly be guessed. Their development presents many difficulties. The marginal areas may be used less in the future than at present. In the semi-arid lands, for example, there have been certain responses to the climate in the past, such as nomadism, which are dying out, and one wonders whether mechanization and so on can outweigh the inherent disadvantages of these lands.

It seems from the maps that for every acre of paddy land there is an acre under the water of an irrigation tank. The principle this suggests might apply to the high land. A part of the high land may have to be used in a manner which is apparently unproductive in order that the remainder may yield food crops.

NOTES

The first issue of a new periodical, *Geographical Studies*, appeared in March from Birkbeck College, London, W.C.1. It has been launched by "a group of third generation British geographers" who believe that greater facilities are needed for the publication in this country of geographical research and discussion. In a brief editorial, Dr. C. A. Fisher demands of geographers "a world view" and disciplined specialist training, and emphasises once again the value of geography in countering the growing estrangement between arts and sciences. The five papers here printed illustrate very well the application of various techniques employed by geographers today. The subscription is 20*s* for one or two numbers a year, and should be sent to Mr. B. L. C. Johnson, Dept. of Geography, The University, Birmingham, 5.

* * *

We have received the first number of a new periodical, *The Agricultural History Review*, edited by Mr. H. P. R. Finberg for the British Agricultural Society. The sphere of the new journal clearly includes much that is of interest to students of historical and economic geography. In this number for example Dr. Joan Thirsk writes on the Isle of Axholme before Vermuyden, and Mr. W. E. Minchinton's paper on "Agricultural returns and the government during the Napoleonic wars" is complementary to that by Dr. H. C. K. Henderson published in the *Geographical Journal*, September 1952. Details of the Society may be obtained from the Secretary, Museum of English Rural Life, 7, Shinfield Road, Reading.

* * *

Aerofilms and Hunting Aerosurveys Ltd. have recently issued a classified index to the large collection of aerial photographs in their Library at 29 Old Bond Street, W.1. This catalogue costs 7/6 and supplements will be issued.

* * *

From March to May 1954, The Royal Ontario Museum of Archaeology, Toronto, mounted an exhibition of historical maps of the Great Lakes region. The seventy-five maps from the collection of Dr. Alexander E. MacDonald, covering the period 1522–1703, dealt with the exploration of the North-west Passage and the opening up of the Great Lakes as a route to the west.

* * *

The Director of Water Development at Dar-es-Salaam has written to the Society drawing attention to the need for hydrologists in East and Central Africa, where a wide field exists for geographers who have had suitable training in physical geography and surveying. An interest in hydrology is of course essential, and Mr. Steele points out that by a hydrologist is meant "a person who deals with natural waters and their application to man's use. His duties would involve gauging of stream flow and rainfall and the relationship between these two and processing of all data thus secured for its use by an engineer, both for water supplies and irrigation purposes."

* * *

The Second International Conference of Teachers of Geography will be held at Drakenburgh, Hilversum, Holland, from August 23 to 28. The President is Dr. W. J. Jong, Heemstede. A number of excursions, including one to the North-east polder of the Zuyder-Zee project, have been arranged. Details can be obtained from Professor A. C. de Vooys, Drift 21, Utrecht.

* * *

We have received from the BOMBAY GEOGRAPHICAL ASSOCIATION the first number of its recently inaugurated periodical, the *Bombay Geographical Magazine*. A brief article recalls the history of the Bombay Geographical Society, founded in 1832 as a branch of our Society and merged with the Bombay branch of the Royal Asiatic Society in 1873. It is noted that degree courses in geography have been established at the Karnatak and Gujrat Universities, and other universities in Bombas State are expected to follow suit.

OBITUARY

ALFRED WILLIAM TALBERT

A. W. Talbert, who was elected a Fellow of the Society in 1938, died on 10 January 1954. He had spent the whole of his working life, forty-six years, in the service of George Philip & Son, Ltd. As a draughtsman he was one of those few who really deserved the title of cartographer, in the seventeenth and eighteenth century sense of the term. He was a master of his craft and could compile and execute a map of any description, having first selected the most suitable type of projection for the purpose in view. No one more than he realized that skill in his craft was not sufficient by itself and he had devoted much time to acquiring the knowledge and understanding necessary to render his cartography truly informative; and he was ever desirous of keeping fully abreast of the results of modern research.

Allied to pride in his craft, Talbert had a very genuine desire to pass on his skill to those whom he trained; his was a modest and pleasing personality and he will be much missed by those who were privileged to work with him. G. G.

ALAN GRANT OGILVIE, O.B.E., M.A., B.SC., F.R.S.E.

Professor Ogilvie collapsed at a meeting of the Royal Scottish Geographical Society on the 10th of February last, and died before reaching the infirmary. He was sixty-seven years of age and had been a Fellow of our Society for nearly forty-two years.

Although he suffered continually from indifferent health after the war of 1914–18, he was one of the most energetic of our academic geographers. To the interests of his department at the University and to those of the Royal Scottish Geographical Society and the International Club in Edinburgh; of the National Trust, the National Committee for Geography, the British Association, the Institute of British Geographers and the Geographical Association; as well as the American Geographical Society and the International Geographical Union, he gave sustained service which often amounted to very hard work.

Ogilvie rose to eminence in geography and to leadership in certain phases of academic life in Scotland, through his belief in the responsibility of the individual for the welfare of society. He prepared himself for his chosen work by becoming a really educated and civilized man. When entertaining African students at his home—eager advocates of independence for the Colonies—he would tactfully explain the degree of responsibility which has to be assumed by

those who aspire to political freedom. For whatever he undertook, whether it were an investigation in the field or the chairmanship of a meeting, he prepared himself carefully. When he wrote, or spoke, he therefore did so with authority. One has only to run through his paper on "The physical geography of the entrance to Inverness Firth" (1914), or his list of authorities for his 'Geography of the Central Andes' (1922), to appreciate the completeness of the investigation for the former and of the organization for the latter. In all his work he set the highest standards of scholarship, and insisted on clarity of exposition. His geography was of the essential kind, concerned more about the production of maps than of books (see *G. Rev.* 13 (1923), 463). The magnificent 'Map of Hispanic America' on the scale of 1/M., though Isaiah Bowman's conception, rests on Ogilvie's foundations, for it was he who listed, classified and evaluated the sources for its compilation before any drawing began (see *G. Rev.* 12 (1922), 655). His critical reports on geographical activities, such as the work of Section E at the South African meeting of the British Association for the Advancement of Science (1929) are part of the record of the history of British geography. In reviewing he undertook little, but accepted the harder work, particularly if it dealt with fundamental considerations. He contributed valuable reviews of such monumental books as Lord Hailey's 'An African Survey' and Volume 8 of "The Cambridge History of the British Empire.' He was among the first to recognize the revolutionary character of Walther Penck's conclusions. He had been at work on a geography of Europe for some years before he died, and we understand that arrangements are to be made for its publication. The collection of his papers and scattered writings into one volume would reward a technical editor willing to undertake the task.

Through his post-graduate studies in France and Germany, his command of several languages, and his attendance at the American Geographical Society's Transcontinental Excursion of 1912, Ogilvie became widely known abroad while still a young man. He had the satisfaction of gaining recognition for his work as it proceeded. His early studies brought him the Society's Cuthbert Peek Grant. For his work on the Transcontinental Excursion of 1912 he was awarded an Albert Kahn Travelling Fellowship which the war of 1914–18 prevented him from taking up. For work in the Aegean and Macedonia, done as a young artillery officer, he was elected an honorary member of the geographical society of Belgrade; for his work at the Paris Peace Conference he was admitted to the O.B.E.; for his 'Geography of the Central Andes' he was awarded the Milne-Edwards medal of the Société de Géographie; and for his work in and for Scotland the Royal Scottish Geographical Society gave him its Research and Livingstone medals, and made him its President. Through his death geography has lost one of its best leaders, Scottish life has lost one of its profound students, Edinburgh has lost an outstanding teacher, and his many colleagues, associates and students have lost a sterling friend. M. A.

CORRESPONDENCE

RIDGE AND FURROW

May I suggest with due respect that Dr. Mead's interesting paper "Ridge and Furrow in Buckinghamshire" (*Geogr. J.* 120 1 (1954) 34ff.) suffers from a lack of perspective in the matter of farming practice and from a latent assumption that, on the open fields, strips and lands were coterminous?

Whenever an asymmetric plough, turning a sod to one side only, is used, a "ridge and furrow" pattern results usually—on practical grounds not connected with drainage. The material question is: how is this pattern treated in succeeding ploughings? and to that there is quite a range of answers, from immediate reversal of the pattern at one extreme, to the gradual building up of "high backed" ridges by multiple gathering (*i.e.* by ploughing always towards the crowns of the same ridges) at the other. Normally, reversal in some form comes sooner or later, giving rise in the case of high-backed ridges in the open fields to a difficulty on the margins of strips with which the Orwins deal in their book, 'The open fields' (1938) pp. 46 f.

The precise site of the axis of a fossil ridge depends obviously on the point in the rotational or operational cycle at which it was left to fossilize, although this may be of minor importance for the explanation of its height, which may depend mainly on the degree of "rigging up" thought suitable for the particular soil, and case. The shift of the axes should not however be pooh-poohed. A shift equal to half the width of the land would be quite normal, and the effect of different methods of combining ridges (see J. E. Ransome's 'Ploughs and ploughing,' 1867, p. 93) must always be considered. However that may be, I would suggest that farming practice in Bucks and elsewhere, in the Gloucestershire vales, for example whose famous "high lands" were discussed by Marshall ('Rural economy of Gloucestershire,' I (1789) pp. 68 ff.), or in the eastern counties, where cultivated "stitches" seem still to exist, would be a better guide than "soil science" to explain what was done.

Perhaps on further reflection Dr. Mead may feel that his classification, recognizing only "ridge" and "no ridge," is too simple. Could we not have had three, or perhaps four, grades distinguished?

With regard to the strips of the open fields, "strips" and "lands" belong to rather different orders of ideas: a good example of how the two things may differ in practice is provided by the 1635 "Survaye" of the Laxton manors, printed by the Orwins in their book (pp. 199 ff), a book which should be read by everyone playing this game (surely a field, not parlour, game) whether starting from the present surface or from the documents. Speaking of documents, was not every Enclosure Award based on a Survey? Ours here was, and the contemporary map of the open fields is in the parish muniments.

Broughton, Hampshire ROBERT AITKEN

THE GEOGRAPHICAL PATTERN OF POPULATION CHANGES IN ENGLAND AND WALES, 1921–1951

In their interesting paper (*Geogr. J.* 119 (1953) 431) Dr. Willatts and Mrs. Newson effectively illustrated the direction and extent of population changes in administrative areas over the last thirty years, mainly by reference to the

upward and downward movements that are revealed by differencing the total enumerated populations at successive Censuses in the various areas. They did not however analyse the net movements fully into their constituent parts of births, deaths and inward and outward migration, or investigate intrinsic fertility and mortality or the influence of age-distribution, all of which differ considerably between various parts of the country. These topics might repay further examination with special reference to housing requirements.

In 1930–32, standardized male death rates varied from under 80 per cent of the national average in rural districts in the Eastern Counties to nearly 125 per cent. in towns in the north-west. Regional fertility variations have been smaller, with a tendency to be in the opposite direction to those for mortality The age-distribution may differ materially between one area and another. In consequence, the contributions of births and deaths towards net population change may be quite unlike in different places. The need for dwellings of various types is probably correlated with the relative strengths of these movements, which may imply different proportions of families of each size. The associations between population characteristics, family sizes and housing requirements under certain conditions have been analysed by Brown and by Glass and Davidson in 'Population studies' (1951)—Vol. IV, p. 380.

The question of how best to present regional population data and their changes is not an easy one to answer. When all factors are taken into account, it is seen that what has arisen is a problem in n-dimensional geometry. Reduction to map form makes it possible to select only one or two dimensions at a time and thus a very large number of charts is required, with a tendency towards qualitative rather than quantitative presentation. There must remain an important place also for tabulations of data, which, if skilfully handled, can show economically some of the more complex classifications. P. R. Cox

Braeside, Headley Drive,
Epsom, Surrey,
6 *January* 1954.

THE STUDY OF LAKE NYASA

The letter from Professor Debenham on the seiche in Lake Nyasa raises several points of interest.

The first of these is that the variation in level would appear to die out approximately one-sixth of the distance along the lake. This can, of course, be explained by the water piling up against the southern shores in the same manner as an ocean tide piles up in a large estuary or on a shallow beach.

The second point of interest is that, despite Professor Debenham's statement, the Sun, if not even more, the Moon, probably is the cause.

In November and February, when the Sun is overhead in lat. 12° S. (mid length of the lake) it will have so little effect that it will probably be unobservable and completely swamped by other variations due to wind, etc.

In June, when the Sun is in north latitudes, it is 35° from the zenith at the mid length of the lake, and the horizontal component of its attraction will be 57 per cent. of its direct attraction (sin 35°). For the hour or so both before and after local noon while this 57 per cent. attraction is active substantially along the major axis of the lake, a tide due to solar causes should be detectable. The test of this will be differences in the magnitude of the seiche between June and December.

As the orbit of the Moon varies somewhat and is (I believe) predominantly

in north latitudes, a similar attraction of water to the north end of the lake should arise from this cause. This should be determinable from observations in November and February while the Sun is overhead, and unable to draw waters either north or south.

At the December Solstice, when the Sun is 10° south of the lake's mid length, it will oppose the attraction of the Moon to some extent.

I am not sufficient of an astronomer or oceanographer, nor have I the time to calculate the magnitude of the tides to be expected from the various causes outlined above, but I expect there are others who will think this phenomenon sufficiently interesting to do the necessary computation.

An additional point that may require attention is the period of resonance for water movements in the lake, both throughout its full length and with the possibility of reflections from the south-east aspect of the shore around Bandawe, at the mid length.

The actual variations in water level observed by Mr. Jollyman are, of course, the peaks of the rebound when the attractive force has passed its maximum some hours after the Sun and/or Moon has crossed the meridian.

If the causes I have suggested are correct, there is not likely to be a tide as the Sun or Moon cross the opposite meridian in long. 146° W. There may be two distinct series of tides, one Lunar, and one Solar, which will augment each other at New Moon and appear separately for the rest of the month.

Interest will attach to supplementary observations at the northern end of the lake, and such will be necessary before any hypothesis is effectively confirmed or denied.

I hope the necessary instruments and a grant will be forthcoming to follow up this very interesting seiche in Lake Nyasa. J. A. C. KING

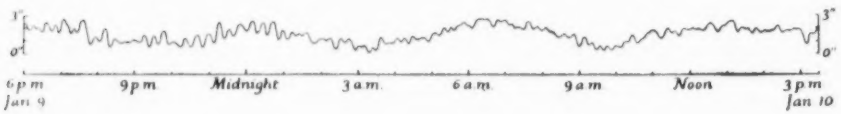
Department of Electricity,
Government of Kuwait,

4 *December* 1953.

Professor Debenham writes:

"Mr. King's interesting suggestions must certainly be followed up through the records are still rather fragmentary. Mr. Jollyman now has a recording drum, sent to him by a Fellow of the Society and he tells me that he is beginning to get 24-hour records. He is, as I expected, much encouraged by the interest shown in his voluntary and somewhat hazardous work, and recently sent me one of his first 24-hour records, on toilet paper, his only source of recording paper at his remote camp at the lakeside near Salima. We reproduce one of these curves, showing very clearly a major oscillation with a six hour period and a minor series with a period of a fraction of an hour. The appropriate periods of resonance along and across the lake, calculated by the Merian formula, agree fairly well with these figures, but more graphs and at different places will be needed before there can be any certainty as to the origin of the oscillation. Mr. Jollyman has noticed a relation between the amplitude of the waves and recent earthquakes in the Mediterranean region."

8 *April* 1954.



MEETINGS: SESSION 1953–54

Meeting of 18 January 1954. Brigadier M. Hotine in the Chair

Paper: A new British stereoscopic plotting instrument for aerial photography. By Professor E. H. Thompson. Joint meeting with the Photogrammetric Society

Meeting of 25 January 1954. Dr. Edward Hindle in the Chair

Film: Land of the long day. Kodachrome sound films of Eskimo life

Meeting of 1 February 1954. The President in the Chair

Elections to Fellowship: Mohan Lal Agrawal, M.A.; Captain J. O. Auclair; Wilfrid J. W. Blunt; Alexander R. Clark; Dr. Peter Connolly; John Cook; Kenneth Cooper; Kenneth P. Dexter; Captain J. H. Evans; Dr. Jon Evans; Peter Haggett; Captain John C. Harrington; Kenneth Hill; Michael Holton; Patrick Horsbrugh; Maynard M. Miller; William G. S. Nixon; Brian Crawford G. Nokes; Edgar Jocelyn Stone; John Thewes, B.A.; Clifford Vanstone, B.SC.

Elections to Associate Membership: Miss Jean Margaret Barker; Miss Catherine M. Childe; Miss Diana Cecily Cooper; Miss Elga Mildred Ellwood; Miss Margaret M. Hall; Miss Susan Mary Lefevre; Miss Sheila Proctor; Miss Anne M. Woollard

Paper: Seven years in Tibet. By Heinrich Harrer

Meeting of 8 February 1954. The President in the Chair

Paper: Aids to the Domesday geography of N.W. Hereford. By Lord Rennell of Rodd

Meeting of 15 February 1954. Mr. Leonard Brooks in the Chair

Film: Bolivian Fiestas. Colour film with commentary by Baroness Fain

Meeting of 22 February 1954. The President in the Chair

Elections to Fellowship: Michael Akenhead; Arthur Baker; Rowland A. R. Bent; Douglas V. Brown; Victor C. Brown; Lieutenant-Colonel Thomas P. Butler, D.S.O., O.B.E.; Lieutenant-Commander A. Card; Arthur R. Chandler; Patrick Durkin; Rev. John F. Ellis; Sir George Erskine, C.B.E.; Hon. Alexander Geddes; Ronald S. Harfitt; Miss Edith A. Hardy; Kendrick W. Harmer; Braham Leslie Harris; John Inch, B.A.; Captain Alan M. Jenkins; Meurig Jones, M.S.C.; Harry Wright Lamb; D. S. S. Mackenzie; Victor David Michelson; David George Mills; John C. Murdoch; William Owen Sloman; John A. B. Stewart, B.S.C; John E. D. Swatman; Eurof Walters; Sydney J. Watson, B.SC.; Thomas Wilson West; Norman Ernest Whiting; John B. Whittow; Reginald S. G. Williams

Transferred from Associate Membership: Miss Pauline A. H. Cordingley; Giles Johnson; David Wedden

Elections to Associate Membership: Derek Henry Andrews; Miss Norma Clarke; Miss Maureen Mary Strugnell; Michael Vivian White

Paper: Between the Oxus and the Indus. By Professor K. de B. Codrington

Meeting of 8 March 1954. Sir Raymond Priestley in the Chair

Film: Alaskan ice field. Colour films with commentary by Maynard M. Miller

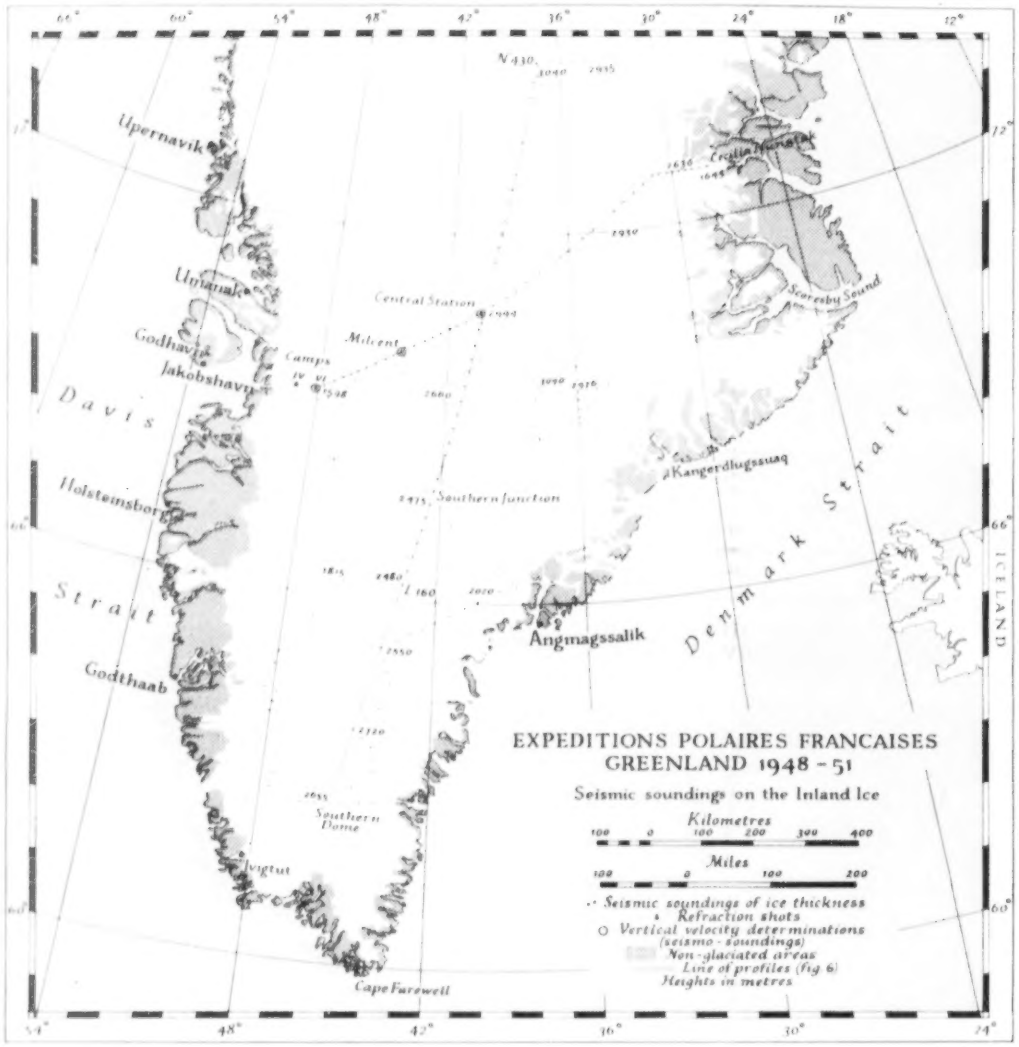


Fig. 1

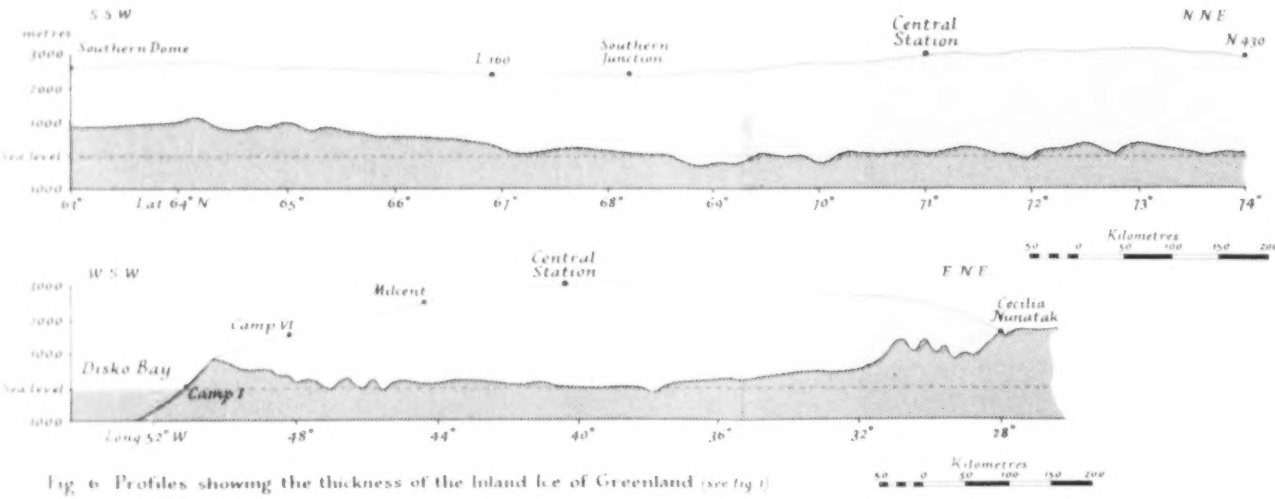


Fig. 6 Profiles showing the thickness of the Inland Ice of Greenland *(see fig 1)*

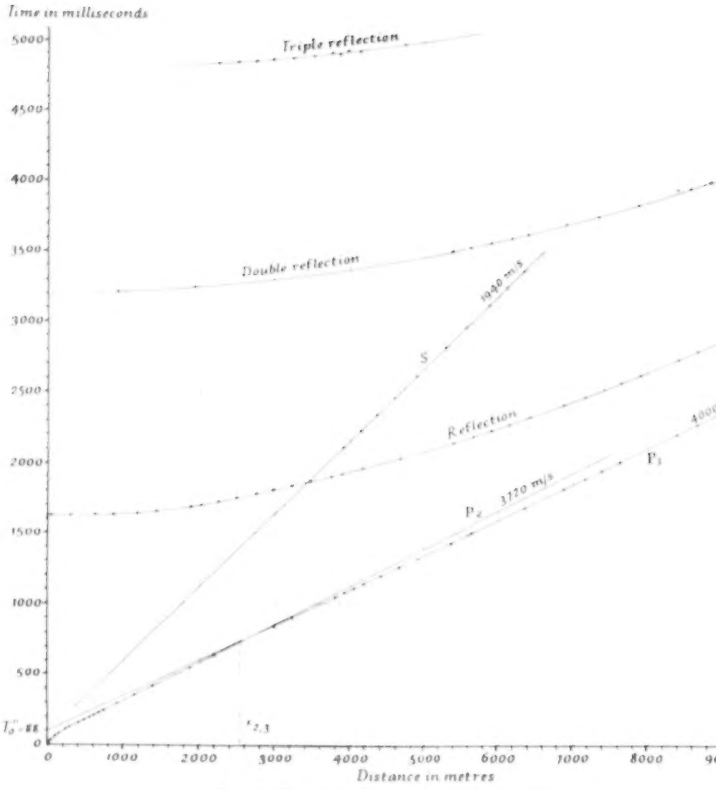


Fig. 4 Travel-time curves : Central Station

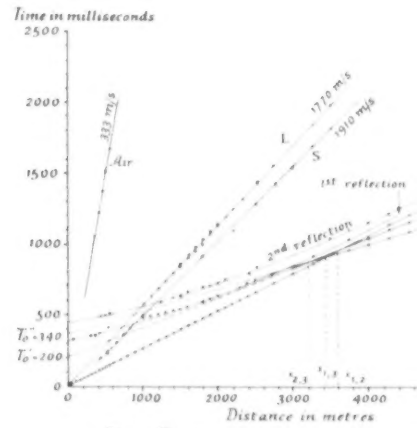


Fig. 2 Travel-time curves : Camp IV

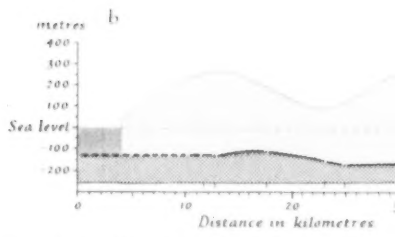
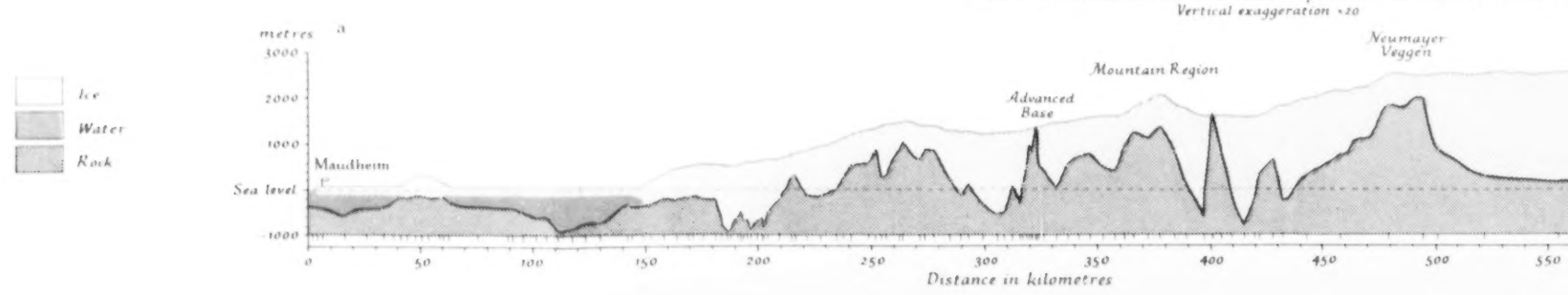


Fig. 7(a & b) Seismic profiles : Dronning Maud Land

The vertical marks above the distance scale show points at which seismic echoes were obt
Vertical exaggeration ×20



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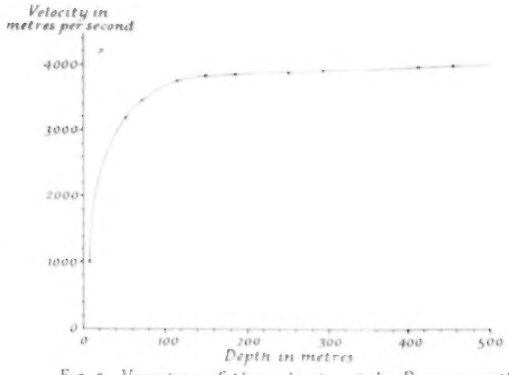


Fig 5 Variation of the velocity of the P waves with depth at the Central Station

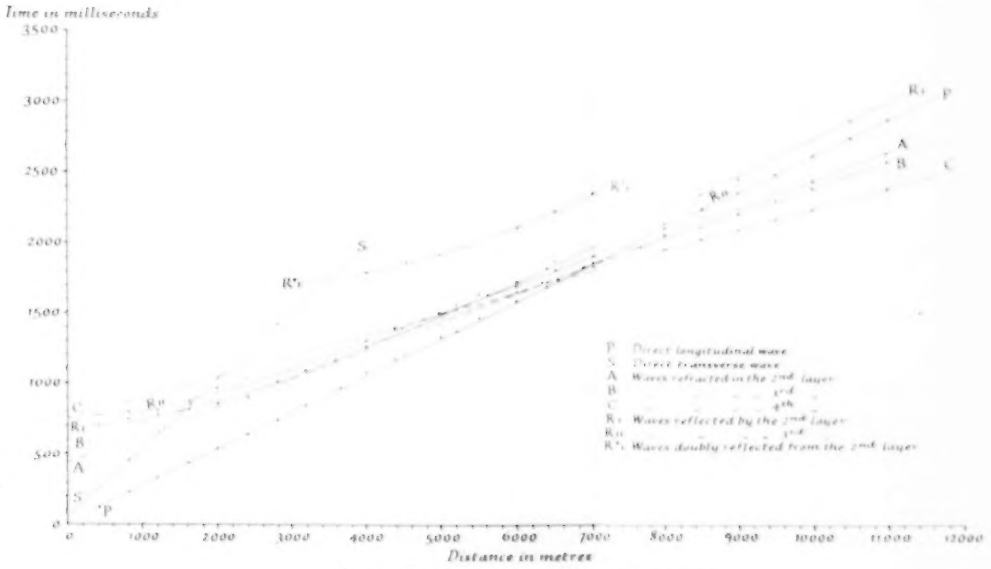
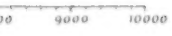
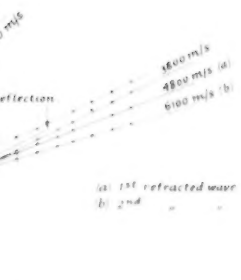
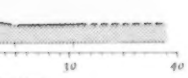


Fig 3 Travel-time curves : Camp VI 1951

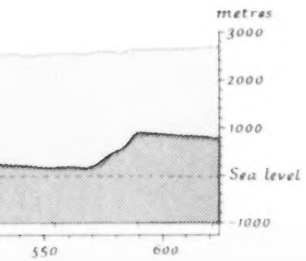




Camp IV 1949



s were obtained



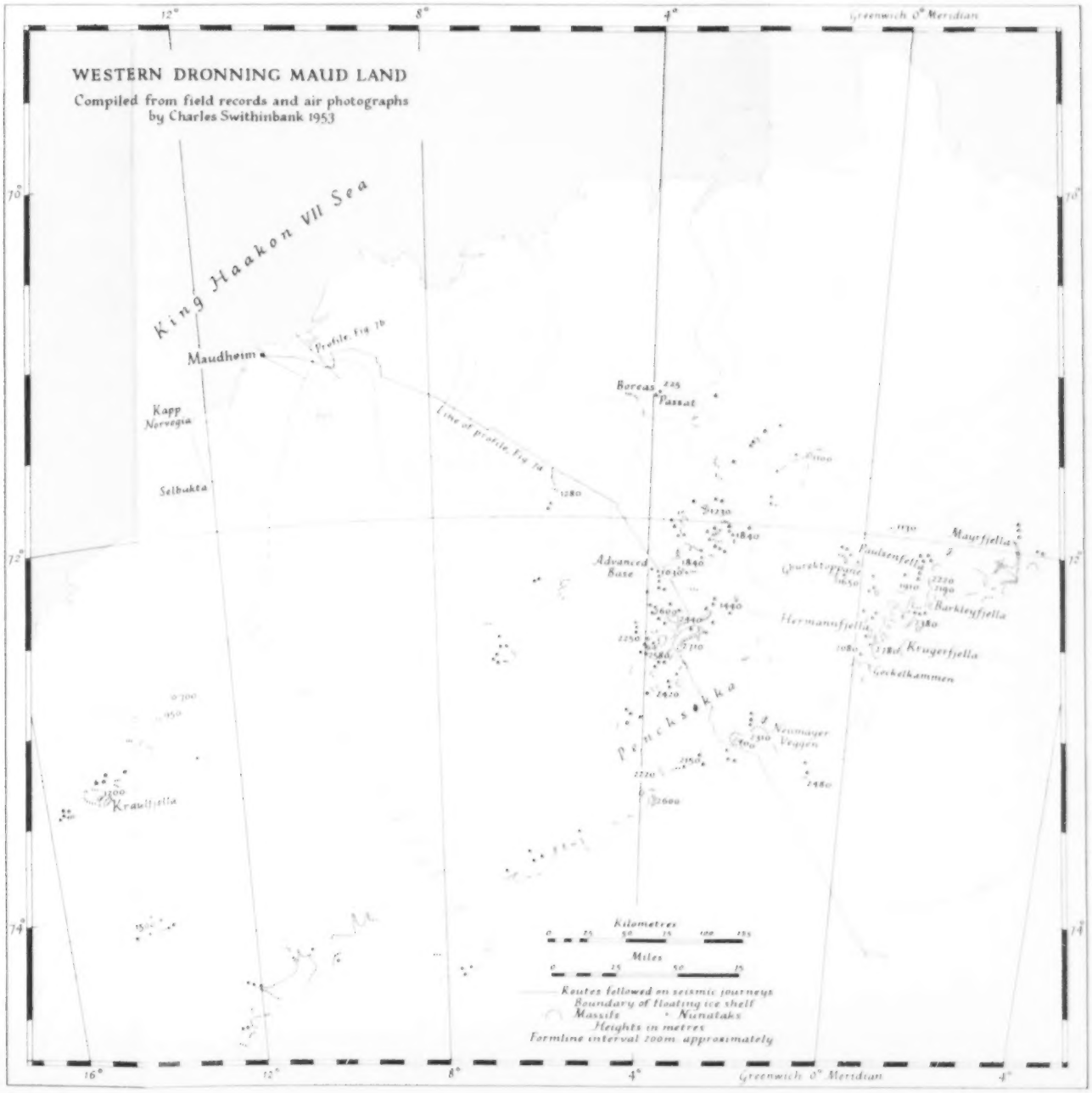


Fig. 8

HOLTZSCHERER & ROBIN

Meeting of 15 March 1954. The President in the Chair

Elections to Fellowship: Anthony Julian Agius; Ian Yorke Ashwell; Miss Pamela B. Baldwin; Lieutenant-Colonel R. E. G. Bartholomew, B.A.; Edgar William Berger; George Leslie Bronsdon; Jack Bucknell; Peter Russell Eakins, PH.D.; Leonard E. Frank; Ian H. W. Haines; H. V. Higgins, M.A., B.SC.; Miss Maude I. Lee; Frederic T. Legg; John Eric Matthews; Lieutenant-Commander J. R. B. Montanaro, R.N.; Ernest C. Nigliazza; Norman B. Palmer; Stanley George Pelling; Robert L. Raikes, B.SC.; John H. Robinson-Fuller; Captain D. W. Rowley; Miss Marilyn Taylor; Leslie James Thornton; Robert Haldane Watson; John Harold Wise, B.SC.

Elections to Associate Membership: Miss Kathleen R. Allington; Keith Gordon Sandford; Miss Anne Christine Weeks; Miss Shirley E. Withers

Paper: The Persian Gulf states and their boundary problems. By Lieutenant-Colonel Sir Rupert Hay

Meeting of 22 March 1954. The President in the Chair

Paper: Oxford University Expedition to Uganda. By J. F. M. Middleton and D. J. Greenland

Meeting of 25 March 1954. Dr. E. W. H. Briault in the Chair

Films: Desert Locust, and other sound films. Films for teachers

Meeting of 5 April 1954. The President in the Chair

Elections to Fellowship: Basil Halsbury Alcazar; D. Aldridge; Keith Berry; Geoffrey Joseph Bond, B.SC.; Michael Charles Carr, B.A.; Dr. Sankar S. Chattergoon, B.SC.; Brian Dalton Copland; Miss Ella S. Crisp, M.A.; Michael John Dowsett; Miss Kathleen Entwistle, M.A.; Dr. Geoffrey Ernest Ffrench; Frederick P. A. Goodwin; William Kenneth Kilford; Dr. S. H. King; Squadron Leader John Robert Macgregor; Miss Diana Charlton Raine; A. T. M. Robertson-Kellie; George M. Sheahan Jnr.; Tom Stacey; His Excellency Christopher Summerhayes, C.M.G., M.B.E.

Elections to Associate Membership: Richard John Perkins; Raymond Henry Preston; David Ingle Smith

Paper: Alaskan Eskimo past and present. By Helge Larsen

Meeting of 12 April 1954. Mr. Leonard Brooks in the Chair

Film: Cornwall. Kodachrome film with commentary by Professor P. W. Bryan

Meeting of 26 April 1954. The President in the Chair

Elections to Fellowship: Mrs. June Back; Mrs. Edna J. G. Bairsto, B.A.; John D. Livingston Booth, M.A.; William M. Carey; Charles Eric Carter, B.A.; Rev. Arthur J. Cornelius; Geoffrey D. Credland, B.A.; Eric A. V. de Candole, C.M.G., C.B.E.; Henry Clive Franklin; A. K. Ghosh; Edward William Golding, M.SC.; Alan Charles Jenkins; Rev. W. R. Jones; Maqsood Hasan Khan, B.A.; Glyndwr P. Kinsey, B.SC.; Miss Greta Lempriere; Dr. Robert J. McConnell; Lewis G. Madley; Edward Joseph Mitchell; Alan Moorehead; Howard Neely, B.A.; Rev. Ian R. K. Paisley; Joseph Pearce Pearce; Gordon Gwyn Scott, B.A.; Don. P. Shidler; James Edward Young

Elections to Associate Membership: John Lewis; Miss Clare Milward; Miss Derian L. A. Siddall

Paper: Marco Polo. An anniversary Lecture by G. F. Hudson

THE ROYAL GEOGRAPHICAL SOCIETY

KENSINGTON GORE, LONDON, S.W.7

FELLOWSHIP AND ASSOCIATE MEMBERSHIP

The object of the Society being the Promotion and Diffusion of Geographical Knowledge, it has always welcomed to its Fellowship those anxious to further this object by their interest and support, as well as those able to take a more active part in the work of discovery and exploration.

FELLOWSHIP

The Bye-Laws provide that a candidate for admission to the Fellowship of the Society must be proposed by a Fellow personally known to him and seconded by another Fellow. Further, that a candidate is not eligible until he (or she) is twenty-one years old, unless he holds a Commission in Her Majesty's Forces or he (or she) is a matriculated student of a University of the United Kingdom or the Self-Governing British Dominions. Proposal forms can be obtained on application to the Director and Secretary.

Every Fellow shall be required to pay on election *either* £4 as Entrance Fee and £4 as Annual Subscription for the current year and thereafter an Annual Subscription of £4 due on 1st January in each year; *or* a single compounding fee of £60.

The Entrance Fee and first Annual Subscription may be paid in four quarterly instalments of £2 each; or the Entrance Fee and first two Annual Subscriptions may be paid in four half-yearly instalments of £3 each. Thereafter the Annual Subscription may continue to be paid in four quarterly instalments of £1 each or two half-yearly instalments of £2 each respectively. Entrance Fee and Annual Subscription may be paid by instalments only where payment is made by Banker's Order. Half-yearly instalments shall be due on the 1st January and the 1st July; quarterly instalments shall be due on the 1st January, 1st April, 1st July and 1st October.

For Fellows who are under the age of 25 years on election the Entrance Fee shall be reduced from £4 to £2. The Entrance Fee and first Annual Subscription may be paid in four quarterly instalments of £1 10*s*. 0*d*. each *or* the Entrance Fee and first two Annual Subscriptions may be paid in four half-yearly instalments of £2 10*s*. 0*d*. each: thereafter payment may be by instalments as above. Entrance Fee and Annual Subscription may be paid by instalments only where payment is made by Banker's Order.

Fellows may compound for their Annual Subscriptions at any subsequent time by a payment of £60 less £2 for each Annual Subscription paid in excess of five with a minimum of £20 after 25 payments.

No Fellow shall be entitled to vote or to enjoy any privilege of the Society while in arrear.

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The Bye-Laws covering the terms of Associate Membership provide that—

1. *A candidate must be not less than 17 and not more than 20 years of age. He (or she) must be recommended by a Fellow, University or School authority.*
2. *Subscription shall be £2 per annum without Entrance Fee.*
3. *On attaining the age of 21 Associate Members become eligible for Fellowship. The Entrance Fee of £2 shall be waived provided they have been Associate Members for 3 years. Otherwise Associate Membership shall cease at the age of 21.*

All subscriptions are payable in advance, on the 1st of January in each year.

PRIVILEGES OF FELLOWS AND ASSOCIATE MEMBERS

The privileges of a Fellow or Associate Member include admission (with one Friend) to all ordinary Meetings of the Society, and the use of the Society's House, Library and Map-room. Each Fellow is also entitled to receive a copy of *The Geographical Journal*. Associate Members have the choice of receiving either *The Geographical Journal* or *The Geographical Magazine*. Associate Members may not describe themselves as F.R.G.S. and have no vote at Annual or Special General Meetings.

A pamphlet giving details of the Society and a copy of the Charter and Bye-Laws will be sent on application to the Director and Secretary.

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